PRACTICAL
ENGINEER

VOL. XVI CHICAGO, MAY 1, 1912 No. 9

STEAM HEATING HINTS

Determining What Type of System to Use, the Amount of the Heat to be Supplied, the Radiating Surface Needed, Sizes of Supply Pipes and Mains, and the Boiler Capacity to be Installed

ACCORDING TO THE METHOD of supplying the heat to the room, heating systems may be divided into 2 classes: direct and indirect. In the former, the radiating surface is installed directly in the room and heat is distributed in the room by radiation and by the rising of a current of air across the heated surfaces and its spreading out at the top of the room to other parts. The current of air, then falling, returns along the floor to the bottom of the heating coils.

In the indirect system, the radiating surface is installed in a flue or passageway where a current of air is blown over the heating surface by either natural or forced draft and this current of heated air is conducted through flues and registers into the rooms to be heated.

Direct radiation is more economical of heat, but it does not permit of the ventilating feature. In houses and smaller buildings, the air which comes in through doors, cracks of windows, and the pores of the walls is usually sufficient for the needed ventilation. In larger buildings which are thickly populated as in the case of schools, churches, theatres and halls, it is usually necessary to provide for ventilation, and the indirect system is used. Frequently, combination systems are employed where a part of the heating is done by the indirect sys-

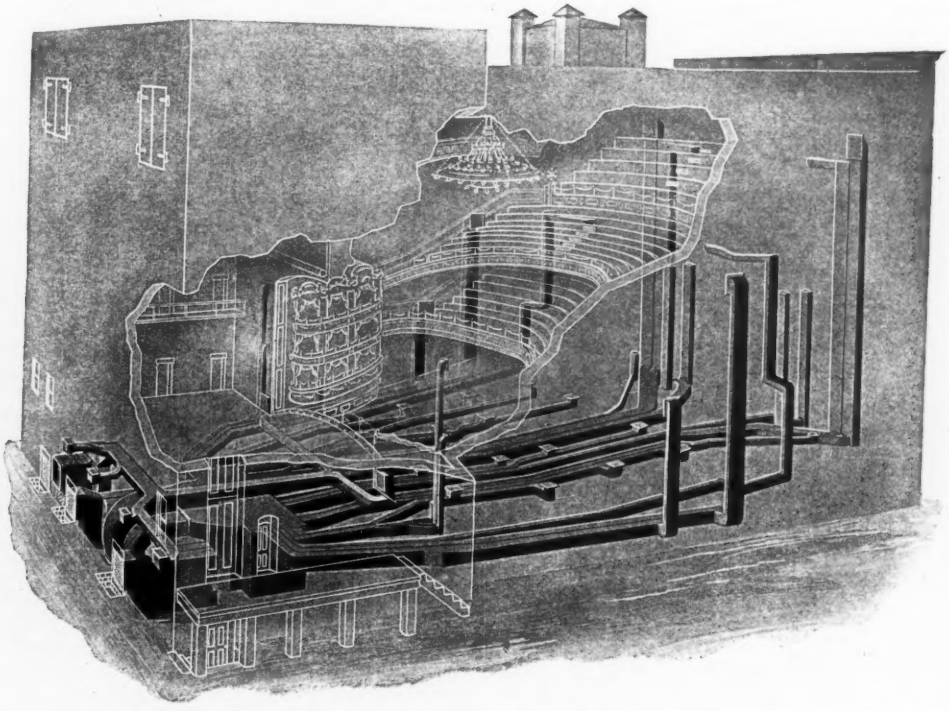


FIG. 2. INDIRECT HEATING SYSTEM WITH VENTILATION AS INSTALLED BY GREEN FUEL ECONOMIZER CO.

tem combined with provision for ventilation; auxiliary heating surface is supplied in the form of direct radiation for spaces in vestibules, near large windows and where currents of cold air might otherwise be encountered.

Methods of Heat Supply

ACCORDING to the method of supplying steam to the radiating surface, steam heating may be divided into 3 systems, the pressure system, the vapor system and the vacuum system. In the first of these the steam is carried at a pressure from 5 to 30 lb. gage, the supply being secured either from the exhaust from a steam engine or from a boiler by passing through a reducing valve, or from a low-pressure boiler. In the vapor system, the steam is supplied at practically atmospheric pressure, the

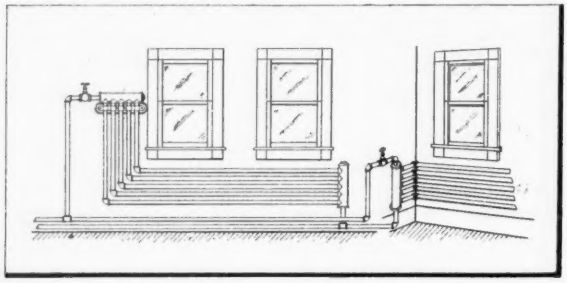


FIG. 1. PROPER INSTALLATION OF DIRECT RADIATION AT COLDEST PART OF THE ROOM

excess of pressure above atmosphere being measured in ounces instead of pounds. In this system the condensation is carried away by gravity.

In the vacuum system, the condensation and air are pumped out of the heating system by means of a steam pump or an ejector and the pressure in a large part of the system is usually below atmospheric, although at the point where steam is delivered to the system it may be at 1 or 2 lb. above atmosphere.

Each method has its advantages. Where it is desired to keep down the size of piping and to use the smallest possible amount of radiating surface, it is necessary to use the high-pressure steam, for not only can a large number of pounds and cubic feet of steam be carried through the pipes at a high pressure, but steam of greater density will be in the radiators, and therefore many particles of the steam will come in contact with the radiating surface, therefore giving up heat to this surface at a rapid rate.

In the vapor system, where exhaust steam is used, the back pressure on the engine is kept low and it is possible to regulate more accurately the amount of heat given out by the radiating surface. The reduction of back pressure is effected without the use of a pump or ejector, and, if steam is supplied by a heating boiler direct, the steam will be made at lower temperature and pressure than with a high-pressure system, consequently will absorb heat from a less intense fire. This is an advantage in the warm days of spring and fall when but little heat is required.

In the vacuum system, a vacuum is maintained on the discharge end of the mains by means of an air pump which handles the air and condensation from the system, or an ejector is used which, acting on the principle of an aspirator, draws the air out of the system and maintains a vacuum in the radiators, thus permitting a low pressure to be used. This keeps low back pressure on the engine if exhaust steam is being used, or it enables the boiler to supply steam to radiators at a low pressure and therefore with a low fire.

Heating the Air

IN using the terms radiator and radiating surface, we perpetuate an erroneous idea, as most of the heat is given up, not by radiation, but by conduction. In dry air containing no moisture or dust particles, the dissemination of heat by radiation is very slow and the air will not absorb heat easily. It is only when dust and moisture are in the air that it becomes possible to heat it sufficiently. The particles of dust and moisture absorb the heat from radiation and give it to the air by contact so that we get the desired rise in temperature.

It is evident, then, a layer of dry air next to a heating surface is a bad thing as it will pass but little heat through itself to the layers of air beyond. A good velocity of air over the radiating surfaces is, therefore, desirable in order that the layer of air next to these surfaces may be kept in motion and carry away heat by contact and conduction. Heating surfaces should therefore be arranged so as to form flues through which the heated air may rise, and, in the case of indirect heating, where air is forced over the radiating coils by fans, the arrangement should be such that every part of the heating surface is hit by currents of air.

Value of Different Heating Surfaces

IT has been found by test and in practice that the relative value of different surfaces for transmitting heat from steam to air is as follows: Cast iron 1.00; wrought iron black or dull 1.93; wrought iron polished 0.72; dull

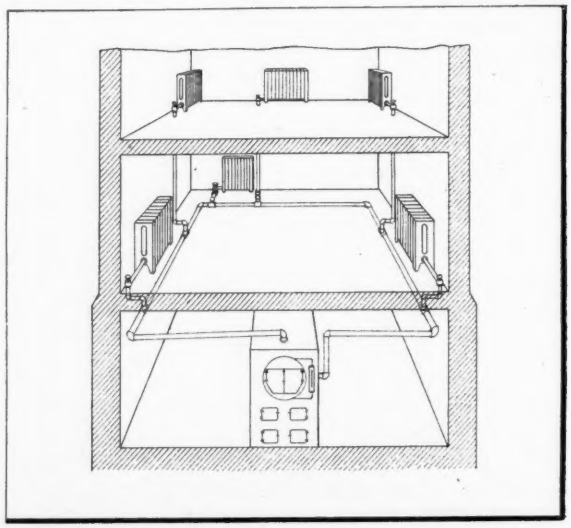


FIG. 3. ONE PIPE CIRCUIT SYSTEM OF HEATING

white 1.06 to 1.09; black asphaltum 1.06; glossy white 0.90; for rough bronzed iron authorities differ from 0.8 to 1.06, the most recent data being in favor of the first mentioned value.

It should be remembered that steam can give up heat to the surfaces faster than the air can take it away, so that the effort for efficiency must be on the air surface, and this may be accomplished by ridging the surface to give greater area, or by arranging in the form of flues to give high velocity of the air, or by the use of artificial circulation.

In the case of pin radiators or corrugated surfaces, however, proportional increase of area can not be counted, as the making of such irregularities tends to increase the layer of dead air next to the radiator surface. In order to get best efficiency from the heating surface, the air should come in contact with all parts of

it; in a pipe coil it is better to put the coil horizontal than vertical, but this is usually not convenient. Two column sections in a radiator are better than more, as there is less reflection of the radiating heat upon itself.

Estimating Heat Needed

IN order to keep a room or a building at a given temperature, as much heat must be supplied by the radiating surface as is lost by transmission through the walls of the room or building and is carried away by air currents. Where no ventilating system is installed, the latter requirement is easily taken care of, as under ordinary conditions the natural ventilation will amount to a change of the air contents of a room about once an hour and 1 B.t.u. is required to heat a cubic foot of air 55 deg. F. The heat required per hour by change of air can then be calculated by finding the temperature change between the outside air and the inside (this is usually reckoned in moderate climates as from 0 deg. to 70 deg.), dividing

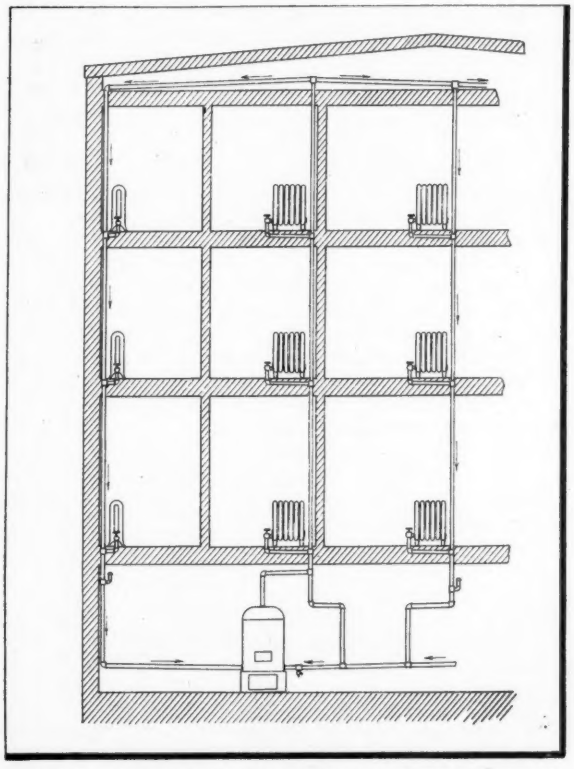


FIG. 4. MODIFIED FORM OF MILLS OVERHEAD SUPPLY SYSTEM

this temperature change by 55 and multiplying the quotient by the number of cubic feet of air space in the room.

For estimating loss through the walls the following values give the number of B.t.u. lost by 1 sq. ft. of surface in an hour for each degree difference between the inside and the outside temperatures. For single window or skylight 1.2; double window 0.6; double skylight 0.65; brick walls, 4 in. thick 0.7; 8 in. thick 0.5; 12 in. thick 0.4; 16 in. thick 0.3; 20 in. thick 0.25; 24 in. thick 0.2; 32 in. thick 0.15; for a wooden wall of ordinary construction 0.3; for floors of fireproof construction 0.2; for double wood floors 0.1; single wood doors 0.4; for roof, covered with slate 1.1; covered with shingles 0.9.

These values are for southern exposures; for other exposures the values should be multiplied by the following factors: north 1.25; east 1.1; west 1.2; all round exposure for an entire building in a single room, 1.16. If the building is heated only by day so that it must be warmed up from a low temperature in the morning, the losses should be multiplied by 1.1, and if in extremely exposed position by 1.3. For buildings that are heated only occasionally, as churches and halls, the values should be multipled by 1.5.

The method of using these values would be to find for a building or for a room the amount of wall surface, of floor surface, of window surface, and of roof or ceiling surface; multiply each kind of surface by its transmission factor and by the degrees temperature difference, which ordinarily would be from —5 deg. to 70 deg., or a temperature difference of 75 deg., and add together all these products to get the entire heat transmitted from the room per hour. This should be added to the heat lost by the change of air and the sum will give the amount of heat to be supplied by the radiating surfaces.

Radiation Needed

PRACTICE has shown that a square foot of radiating surface will condense about a ¼ lb. of steam an hour and will give 250 B.t.u. an hour if of wrought iron, or 225 B.t.u. an hour if of cast iron. This is on the basis of 5 lb. gage pressure for the steam at 228 deg. F. If steam of a different pressure is used, the heat given out per square foot of radiating surface should be divided by the factors in the following table.

Pressure		
Absolute	Gage	Divisor
6	— 9	1.69
8	— 7	1.49
10	— 5	1.35
12	— 3	1.25
14	— 1	1.17
16	+ 1	1.10
20	+ 5	1.00
25	+10	0.91
30	+15	0.84
35	+20	0.79
40	+25	0.74

Having found the B.t.u. given out per square foot of radiating surface, divide the total number of B.t.u. needed an hour by this figure and the quotient will be the number of square feet of radiating surface required.

If wrought-iron coils are used, the linear feet required may be found in data tables published in back issues of Practical Engineer or may be computed on the basis of 3 ft. of 1 in. pipe per sq. ft. of radiation; 2.3 ft. of 1¼ in.; 2 ft. of 1½ in.; 1.8 ft. of 2 in.

For cast-iron radiators the amount of surface is as indicated in the table herewith.

SURFACE ON 2 COLUMN RADIATOR IN SQ. FT.

No of Sections	Length in inches	Sq. Ft. Heating Surface 20 in. high	26 in. high	32 in. high	38 in. high	45 in. high
2	5	4	5⅓	6⅔	8	10
4	10	8	10⅔	13⅓	16	20
6	15	12	16	20	24	30
8	20	16	21⅓	26⅔	32	40
10	25	20	26⅔	33⅓	40	50
15	37½	30	40	50	60	75
20	50	40	53⅓	66⅔	80	100

Three column has 1½ and 4 column 2 times the surface of a 2 column radiator of given number of sections.

With ordinary construction for certain classes of buildings, there will be roughly an average ratio of window surface to wall surface and of wall surface to room

and floor surface so that an estimate can be made of the radiation required by considering the capacity of the rooms or the buildings. On the basis of the assumptions heretofore made, a square foot of wrought-iron radiating surface will take care of 50 cu. ft. in houses and one-story shops; 70 cu. ft. in banks, offices and 2-story shops; 100 cu. ft. in retail stores; 125 cu. ft. in hotels and wholesale stores; 200 cu. ft. in churches and halls. These values are for heating by direct radiation.

If indirect radiation is used in buildings such as schools and halls where considerable numbers of people are housed, the radiation should be increased 25 per cent, and if comparatively few people are housed, by 40 per cent. If the building is in an exposure where there are strong, bleak winds, radiation found should be multiplied by 1.2, and if cast-iron radiating surface is used the amount should be increased by 10 per cent. It should be noted that this is only an approximation at best, and

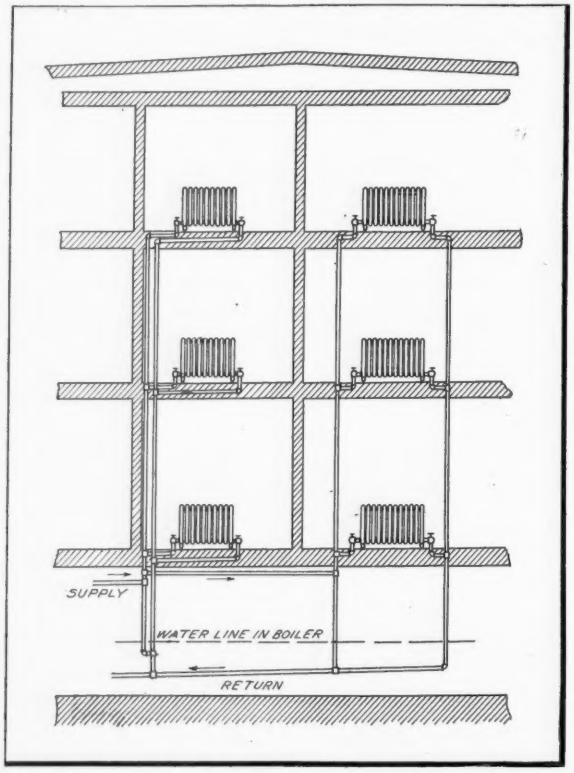


FIG. 5. TWO PIPE PRESSURE SYSTEM OF PIPING

allows for the usual proportions of window space to wall space. In the case of a shop having a large increase in window space over usual practice or in such a building as a green house or a shop with walls of a single thickness of galvanized iron, the values would not apply.

Ventilation Requirements

IN ordinary air there are found about 4 parts of carbon dioxide or CO_2 in each 10,000 parts of air. The burning of fires and gas jets, and breathing of persons increases the amount of carbon dioxide and when this increase amounts to 2 parts in 10,000 in excess of that in ordinary air, the room becomes as we call it "close." It is necessary, therefore, to supply sufficient fresh air so that the carbon dioxide shall never exceed 6 parts in 10,000.

The adult male gives off 0.7 cu. ft. of carbon dioxide per hour; the adult female 0.6 cu. ft.; the child 0.35 to 0.5 cu. ft.; an ordinary oil lamp or an ordinary gas jet 1.2 cu. ft. To determine therefore, the amount of air to be supplied, find from the figures just given the number of cubic feet of carbon dioxide which will be produced per hour by the people and lights in the room; multiply this by 10,000 and divide by 2; the quotient will be the cubic feet of fresh air to be supplied each hour.

This air must be heated as it enters the room in order to keep up the temperature, and we find the number of B.t.u. needed by the rule as heretofore given: Divide the temperature difference between the outside and inside air (this is usually 75 deg.) by 55 and multiply by the number of cubic feet of air needed an hour. This will give the heat to be supplied each hour on account of ventilation.

We have, however, a certain amount of heat supplied by the occupants of a room and by the lights. The amount thus supplied will be 400 B.t.u. for each person; 600 B.t.u. for each electric light and 4500 B.t.u. for each gas jet per hour. This amount of heat for the people and lights in the room can be subtracted from the amount to be supplied for ventilation or to make up for transmission.

Supply Pipe Sizes

TO determine the size of pipe needed for supplying radiation it is necessary to consider the drop in pressure which may be allowed in the pipe and the amount of steam which must be carried. From the data already given, it is evident that the amount of steam to be carried through the mains will depend on the number of square feet radiation, since 1 sq. ft. will condense about ¼ pound an hour. For ordinary low-pressure heating ¼ to ½ lb. drop in pressure is usually permissible. The length of pipe determines the amount of drop, and experience and the theory of the flow of steam indicate that with a supply pipe 100 ft. long or less and with ½ lb. drop the following amounts of radiation will be supplied by different sizes of pipe:

For 1 in. pipe, 114 sq. ft.
For 1¼ in. pipe, 210 sq. ft.
For 1½ in. pipe, 340 sq. ft.
For 2 in. pipe, 750 sq. ft.
For 2½ in. pipe, 1350 sq. ft.
For 3 in. pipe, 2210 sq. ft.
For 3½ in. pipe, 3290 sq. ft.
For 4 in. pipe, 4620 sq. ft.
For 5 in. pipe, 8220 sq. ft.
For 6 in. pipe, 13200 sq. ft.
For 7 in. pipe, 19620 sq. ft.
For 8 in. pipe, 27720 sq. ft.

If ¼ lb. drop only be available, the square feet radiation will be about 0.7 that when ½ lb. drop is available. If the pressure is less than 3 lb. gage, the ¼ lb. drop values should be used. If the supply pipe is more than 100 ft. in length, the radiating surface to be supplied should be multiplied by the following factors: For 125 ft., 0.9; 150 ft., 0.8; 175 ft., 0.75; 200 ft., 0.7; 225 ft., 0.65; 250 ft., 0.62; 275 ft., 0.6; 300 ft., 0.57; 350 ft., 0.53; 400 ft., 0.5; 450 ft., 0.47; 500 ft., 0.45; 600 ft., 0.4; 700 ft., 0.37; 800 ft., 0.35; 900 ft., 0.33; 1000 ft., 0.3.

In figuring the length of main through which steam is to be carried, the equivalent pipe length of fittings and valves should be included. For a right-angle elbow, 40 pipe diameters should be added; for a globe valve 125 pipe diameters; for a tee 60 diameters.

The values as given above are for direct radiation. For indirect radiation 1 sq. ft. of surface should be reckoned as equal to 2 of direct radiation in computing pipe sizes. The returns as a usual thing are made one size smaller than the corresponding steam pipes in a 2 pipe system; if a 1 pipe system be used, so that steam and

water both flow in the same pipe, the pipes are good for only 40 per cent of the radiation as figured above.

In making connections to radiators or coils, the size of connection as given by Monroe is: for 25 sq. ft. of surface on 1 pipe system, ¾-in.; for 50 sq. ft. 1-in.; for 85 sq. ft., 1¼-in.; for 130 sq. ft., 1½-in. For 2-pipe connection, the steam connection would be ¾-in. up to 40 sq. ft. and return ½-in. Steam connection 1-in. up to 75 ft. and return ¾-in. Steam connection 1¼ to 120 ft. and return 1-in. Steam connection 1½-in. up to 180 ft. and return 1-in.

Boiler Capacity Needed

IT is usual to assume that 1 boiler horsepower will supply steam for from 100 to 130 sq. ft. of radiating surface, although it is evident that this depends on whether the surface is direct or indirect and whether it is cast-iron radiators or pipe coils.

Another basis for figuring is that 24 by 50 in. of

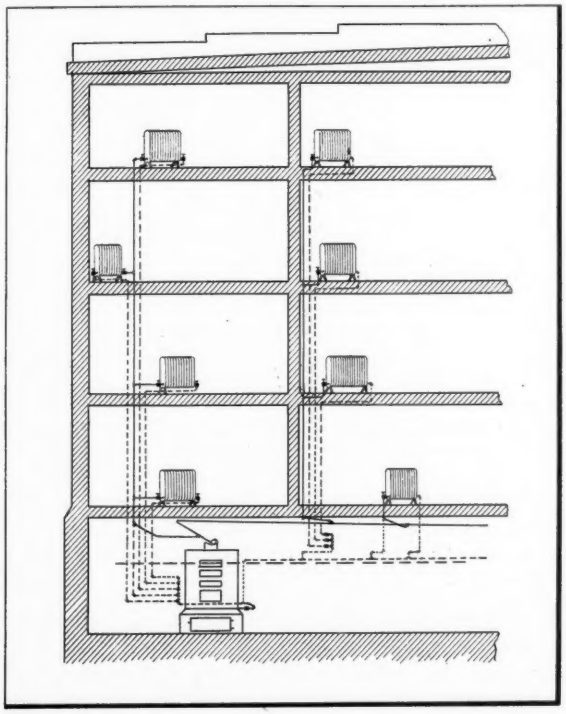


FIG. 6. COMMON FEED AND SEPARATE RETURN AS USED IN THE VAPOR SYSTEM TO INSURE CIRCULATION

grate surface will supply 1500 sq. ft. of direct radiation or 750 sq. ft. of indirect. This would amount to about 180 sq. ft. of direct radiation per square foot of grate surface or 90 ft. of indirect per square foot of grate surface.

Another method of figuring would be that the grate surface would be equal to the heat to be supplied to the entire plant as figured when determining the radiation required divided by 54,000. This method is based on the assumption that 6 lb. of coal will be burned per square foot of grate surface per hour and that 9000 B.t.u. will be utilized for each pound of coal burned. The power of heating boilers is on the same basis as that for power boilers and amounts to the ability to supply about 33,330 B.t.u. an hour. As a rule, the heating surface is not, however, as efficient as in the case of the power boiler on account of the low rate of combustion and lower temperature, so that from 15 to 18 sq. ft. of water heating surface should be allowed per boiler horsepower..

POINTS ON A VACUUM SYSTEM

Methods of Piping, Starting, Draining and Caring for Exhaust Steam Vacuum Heating System

By George H. Wallace

WHILE the time is past for the use of heating appliances for the present season, and any changes or additions that are likely to be made to them, yet it is not too early to think of the season that is to come and have everything in the best order when the time comes to use steam heat.

Without a doubt, there is no part of the equipment that usually comes under the supervision of the engineer, that is given less attention, thought and care than the heating of office or factory and have everything work as satisfactorily as it should.

Up until a few years ago practically the only method of heating large factories was by the time honored method of straight exhaust steam, and a little earlier, live steam was almost universally used for this purpose, and still is to a surprisingly great extent.

There was usually no system in vogue to proportion the radiation to the contents of the room or building, or to make any investigation as to the construction of the building. The fact that one building was covered with a single thickness of No. 3 matched fencing, was not thought to require any more radiation, than a building of similar size that was double sheeted and papered outside and in, or if it was it was guessed at.

The principal fault, however, with these early systems was that the mains were usually much too small, in which case, during the greater part of the winter, a back pressure of from 5 to 10 lb., or even more, was required to make any attempt to heat the buildings fairly warm for "moving labor," much less for those whose work demanded that they remain in one place constantly.

In cases like this it was, and is yet, customary to turn in live steam in a vain attempt to secure and maintain the desired temperature, and this when there was an abundance of exhaust steam going to waste.

Every reader of this article knows of instances in his locality, perhaps in his own plant, where such conditions exist even in this day and age when the watchword is "conservation."

Then it is really wonderful the way that the returns from the various heating systems are being wasted, for once having performed its duty to man, even under the most discouraging conditions, the returns are all too frequently allowed to run to waste, sometimes to the sewer direct, but more often outside the building in the most direct route where the continual presence of water soon works considerable mischief with any kind of building construction.

There is another source of waste connected with this method of disposing of the condensate which comes more under the head of maintenance than of operation, and that is the frequency with which this wasteful method of disposal freezes up, even in temperatures slightly below freezing, thus rendering inoperative that part of the system which is served by the frozen drain.

Very often in such instances, not only does the drain pipe freeze but the radiator is rendered inoperative by reason of filling with water which reduces the temperature of the surrounding air to the point where the radiator soon freezes. Then there is the expense

of repairing the radiator, even going so far at times that it is necessary to discard the old one entirely and install a new one, the loss or damage to stock or product from escaping water or steam is sometimes considerable of an item while the loss to both employer and employee is inestimable because men cannot work and turn out a good article when the temperature of the room is so low as to make it uncomfortable, let alone the liability of sickness.

In many of the factories, the growth of the business has made it necessary to add to the factory from time to time and each time it seems that there will never be another demand for additional room. Thus the entire factory is frequently without any definite system, not only in regard to the economical handling of material in the process of manufacture, but in regard to heating these various additions in the best manner.

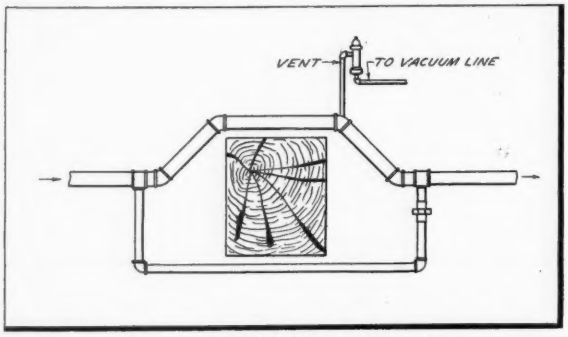


FIG. 1. PASSING A HORIZONTAL OBSTRUCTION WITH SUPPLY LINE

Sometimes a live steam line is run to some of these additions as a temporary means of heating it, in the hopes that at some future date the matter can be taken up and solved right.

To a certain extent, local conditions must govern the selection of the system used in a general way. Certain conditions make a fan blast the best; others can be served best by radiators placed along the walls in suitable sized coils, or manifolds; while in other instances coils can be suspended from the ceiling in such numbers that the necessary amount of radiation is secured.

This last system gives the best results where there are numerous pulleys and belts to accelerate the circulation of the air, and especially so if it is not convenient to place coils of pipe along the walls on account of doors or other openings, or obstructions in the shape of stock bins or material piled along the wall which would injure the coils or their efficiency.

Of late years, considerable attention has been given to the vacuum system of heating, and several excellent systems have been placed on the market with good success.

It is a commonly committed error to think that as long as a vacuum system is operated at all the way from a pound or two pressure to several pounds vacuum, that rigid or tight construction is not necessary, yet, as a matter of fact, nothing will cause a vacuum system to fail so utterly, as a small leak, for the very principle on which it operates is that a vacuum of a certain number of pounds be maintained constantly and this cannot be done unless the system is absolutely tight.

If it is decided to install a vacuum heating system, look the ground over carefully as to the best and most convenient way to run the main or mains. Then begin at the room or building at the end of the main and figure the necessary amount of radiation required to heat to the required temperature. The basis usually selected is a uniform inside temperature of 60 deg. with an outside temperature of 20 deg. below zero.

There are variations, however, from this standard, depending on the conditions to be met. But whatever is decided on as the proper radiation for the room or building, figure the size of the main necessary to convey the necessary amount of steam to this radiation, as if this was all there was to it.

Then go back towards the main steam supply to the next building, room, or group of radiators, and figure the same way and adding to this the size of main which was found necessary for the first group and then figure the size of main necessary to serve both, and in this way work back towards the original supply of steam.

Use the same method in porportioning the return mains, only keep in mind the fact that you are now

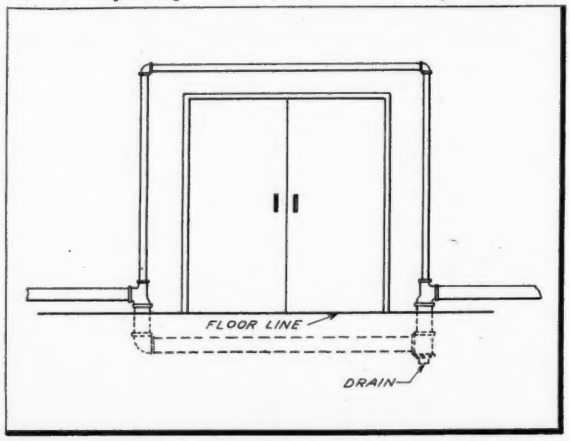


FIG. 2. PASSING AN OBSTRUCTION IN THE PATH OF THE RETURN PIPE

dealing with water instead of steam. While a vacuum pump will handle returns, even if it is some higher than the return main, yet on this account do not make your return lines any more tortuous than can be helped.

After having proportioned and planned the system as a whole, begin where the steam leaves the exhaust main, and lay your heating mains so that there will be a gradual fall in the direction of the flow of steam of about an inch in 10 ft. Where reductions are to be made in the main use eccentric fittings so that the bottom of the main will be on a straight line, to permit water of condensation to flow easily with the steam.

If installing a system where the vacuum is maintained in the radiators by a line separate from the return, take the supply from the top of the main to the radiators, which in all cases should be above the main, and let the returns drop down and enter the supply main from below with a swing check valve inserted near the main.

This water seal should be from 6 to 10 in. deep and it will properly drain a radiator which is only 18 in. above the supply main. If convenient, however, to do so and the general arrangement makes it necessary, the return from a radiator can be drained directly into the return main. Drain the end of the supply main directly into the return main, leaving a ¼-in. pipe connection at the end just before the drop, for connection to the vacuum line, as will be explained later.

Should it become necessary in laying the supply main to pass some horizontal obstruction, such as a

beam as in Fig. 1, arrange for an ample drain to pass under the obstruction while the supply main goes over the top and resumes the original line.

And if it is found that the return line will have to be dropped to clear an obstruction, such as a doorway, let the main drop below the floor as shown in Fig. 2, but run a vapor pipe of not less than 1-in. pipe over the obstruction as shown. These 2 devices will maintain the equilibrium of the lines to which they are attached.

Before erecting the radiators, drill and tap the branch tees at the outlet for ¼-in. pipe as shown in Fig. 3, at about half way between the first and second pipe from the bottom. Run the ¼-in. pipe upwards as shown, to about the top of the radiator, at which point apply the automatic vacuum valve, and from this run a pipe to the vacuum line which should not be less than 1-in. pipe.

If any of the radiators are horizontal, such as those suspended from the ceiling, drill and tap for ¼-in. pipe about the middle of the branch tee and run a short riser upward about a foot before attaching the automatic vacuum valve.

Continue the 1-in. vacuum line around in the most convenient way to about where it is intended to locate the vacuum pump, attaching all connections from vacuum valves, and high spots in the supply main. On the main return pipe from each building or group of radiators, locate one or more, expansion, or other reliable continuous flow traps, of such number or size that they will pass all the condensation likely to come during the most severe weather, and yet not permit the passage of steam.

Provide suitable valves and pipe so that the traps can be by-passed in case of emergency and continue to operate the system on the straight gravity return principle till repairs can be made.

Connect the main supply pipe to the source of exhaust steam with a suitable cutout valve and also an arrangement for admitting live steam to the system at a pressure ranging from, say 5 lb. down to ½ lb., or less. A valve should also be provided to admit live steam around the pressure reducing valve to the heating system, governing the supply by hand regulation, so as to keep the factory warm should the reducing valve become deranged when there is no exhaust steam available.

Locate the vacuum pump where it is accessible, and where it will be clean, giving preference to the location that is well lighted. Connect all the return mains from the various buildings or departments into one main and connect to the suction of the pump, placing a gate or angle valve close to the pump. At a convenient place near the pump, provide an outlet to connect direct to the sewer for use as will be explained later.

Connect the 1-in. vacuum line into the top of the return main close to the pump, also a cold water connection of about ½-in. pipe from some permanent source under pressure. The object of the latter is to provide a means of cooling the return water to a point where the pump will handle it nicely. Under ordinary conditions this is about where the hand can be placed on the discharge pipe of the pump.

On the steam supply to the pump place a reliable vacuum governor so that the speed of the pump is regulated by the vacuum which it is desired to carry in the line, which varies with conditions.

The discharge of the pump can be led to an open heater or to an expansion tank (if not too high) or to the receiver of a boiler feed pump but wherever it is lead, suitable vent must be arranged for, to the atmosphere to take care of the air exhausted from the system.

If it is a new system, or one remodeled in which considerable new pipe has been used, it is best to operate it at least 2 weeks or so on the straight back pressure system with all traps bypassed for there is always considerable oil, chips, scale, grit, etc., in the pipes which must be removed and which would not only tend to clog or ruin the traps or pump, but which might cause foaming in the boiler if introduced into it.

When satisfied that the returns from the system are suitable for use, go over every vacuum valve and regulate it under a pressure of a pound or so of steam and adjust it so that it will just close when the entire radiator is hot.

This being done, start the vacuum pump and turn on the steam, then the cold water a small amount and regulate this amount till the desired temperature is secured. If the system is well designed and constructed there need not be over a pound of back pressure on the engines in the most severe weather, and under ordinary conditions the pressure will range from zero to from a few ounces to 3 lb. of vacuum.

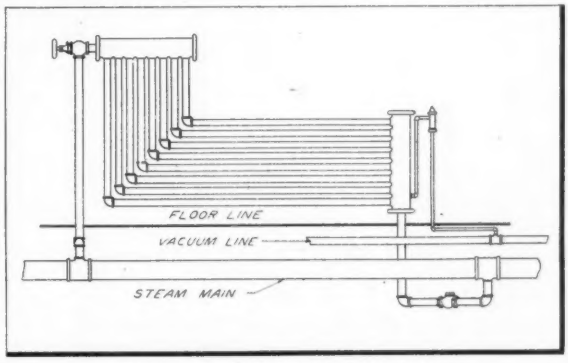


FIG. 3. RADIATOR CONNECTIONS

The problem of cylinder oil in the system is one that requires more attention with a vacuum heating system than with any other and the oil must be separated from the steam before entering the system. Even if the exhaust steam is all run through a separator before being lead to the system, it is advisable to install another one on the main supply pipe for if the oil once gets into the system it not only impairs the radiation surface but it is liable to get into the boilers where it can do much mischief.

It sometimes occurs that a radiator will not heat up properly. Instead of adding more backpressure in a vain attempt to force the steam into the radiator, take the vacuum valve apart and clean it thoroughly for it is liable to become coated with sediment to such an extent that it obstructs the openings. This is especially liable to happen in new systems till the pipes and radiators become thoroughly freed from sediment, or when first starting the system in the fall when the pipes are coated on the inside with rust.

In turning on radiators, it is only necessary to open the inlet valve, but see that it is opened full, for if only partly opened or cracked from the seat, the radiator is liable to fill with water and cause considerable annoyance. Keep all valve stems well packed and discourage tampering with the system by workmen or others, except some one authorized to look after it, unless it be to turn the heat on or off as necessity demands.

THE "RELIABLE" AIR LINE SYSTEM

Dry Vacuum Pump to Remove Air Through Automatic Valves Without Drawing Away Steam. Resulting Low-Pressure Decreases Coal Used On House or Shop Systems

THIS vacuum system manufactured by The Bishop-Babcock-Becker Co. for use with steam heating plants and known to the trade as the Reliable Vacuum System, is substantially an air line system. It consists of a dry vacuum pump and condenser with automatic regulator, and nonadjustable automatic air valves connected by a system of air piping to the condenser and pump.

Pumps and Control

RELIABLE vacuum pumps are made in 2 types, hydraulic and electric, and in various sizes to suit the requirements of any type or size of building. The hydraulic vacuum pump has 2 vertical cylinders, one for power purposes, and the other for exhausting air from the heating system.

The electric vacuum pump is the duplex vertical double-acting type, compactly built and mounted with motor on a heavy cast-iron base, and back-geared to the motor with 2 speed reductions.

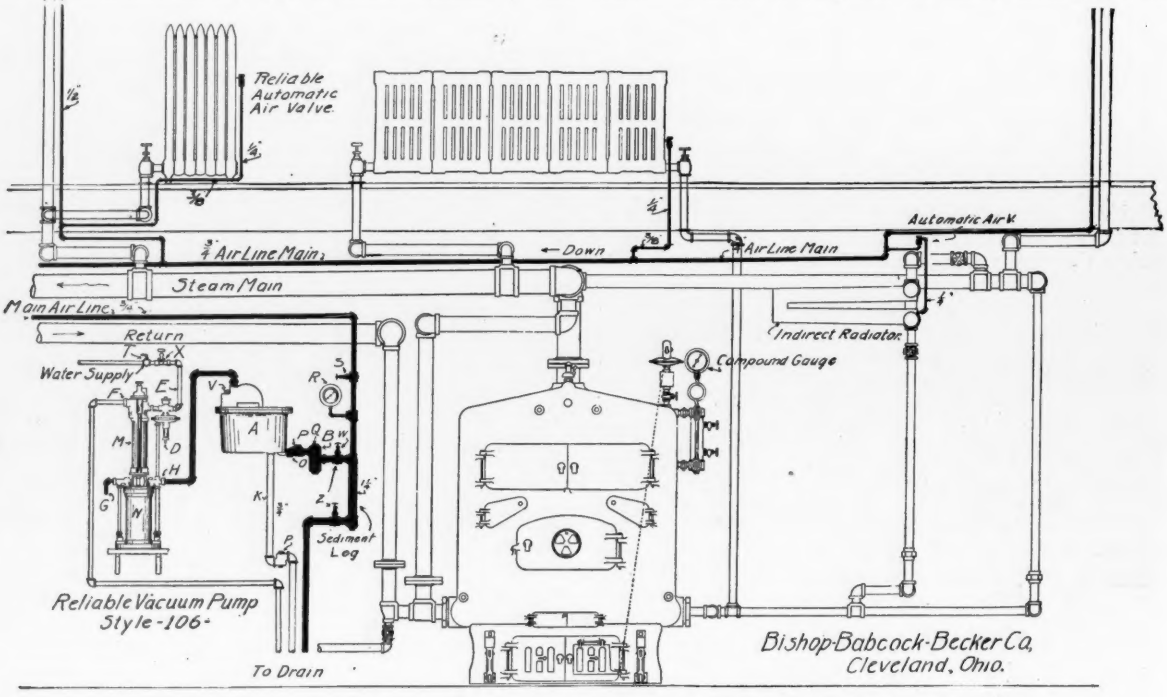
Both hydraulic and electric pumps are equipped with an automatic cutoff which can be set to maintain any desired degree of vacuum in the heating system. When this degree of vacuum is reached the cutoff will stop the pump and it will remain quiet until air accumulates in the radiator.

It can be readily seen that this cutoff device prevents the consumption of water or current by the pump except at such times as there is air to be removed from the system; consequently the operating expense is small.

The advantage of using a nonadjustable automatic air valve that has been adjusted at the factory, with the adjustment as well as the air valve guaranteed, will be readily understood, especially by the heating contractor who has had the expensive experience of adjusting and readjusting air valves.

Operation

OPERATION of the air line vacuum system as illustrated by the accompanying drawings is as follows: The vacuum pump being put in operation, a partial vacuum is soon produced in the radiator and the steam flows in quickly, and fills the entire radiator, with the result that the building is heated to the desired temperature in a short time. With a pressure system the air has to be forced out of the radiator by the steam as it enters, taking considerable time. An advantage that every householder and occupant will appreciate is the absence of unpleasant odor escaping into the room from the radiator through the air. Even distribution of steam throughout the entire heating system quickly and quietly is obtained by the use of this vacuum system.



THE "RELIABLE" AIR LINE VACUUM SYSTEM INSTALLED BY THE BISHOP-BABCOCK-BECKER CO.

Considering the various classes of buildings, (A) those having isolated power plants where the exhaust steam is used for heating; (B) those having isolated low-pressure plants for heating only; (C) those taking steam from central heating plants: In class (A) where the exhaust steam is utilized for heating purposes, the vacuum system maintains a partial vacuum in the radiator, relieving the engines and pumps of back pressure which would otherwise be required to force the air out of the radiators and force the steam through the heating system, a concrete case where "Persuasion is better than force."

Where the exhaust steam is used for heating without back pressure, the cost of steam production in winter is but little if any greater than in summer. With a vacuum system, the building can be heated at

atmospheric pressure in cold weather and much below atmosphere in mild weather. When the oil and foreign matter are eliminated, exhaust steam is as valuable for heating purposes as live steam.

Referring to class (B), economy from the use of the vacuum system with a low-pressure plant is obtained for a different reason than from that which obtains with the combined high and low-pressure plant.

In mild weather a low fire can be carried, and the dampers checked, so that the vacuum of condensation will take place in the boiler and heating system often to a greater degree than that produced by the pump. Under these conditions the vacuum pump will remain quiet indefinitely and only the amount of fuel will be burned that will produce a sufficient amount of steam (at the low temperature corresponding to the degree of vacuum maintained) to heat the building properly in this mild weather.

With heating plants where steam is supplied from central stations, if the pressure is reduced to such a low point near the ends of the mains and laterals that it will not force the air out of the radiators sufficiently to permit the steam to fill them, plants equipped with the vacuum system have the advantage, as the air will be removed by the vacuum pump producing a partial vacuum in the radiators, so that the steam will fill them quickly.

As the requirements are becoming more exacting from day to day, heating systems must operate quietly; radiators must heat quickly; piping must be small enough to conform to modern conditions. Less steam must be used for heating in mild weather, calling for a flexible system so that a reasonable steam pressure can be maintained in cold weather and any reasonable degree of vacuum in mild weather. Uniform and positive circulation must be secured throughout the entire heating system. All heating surfaces must work constantly at their greatest efficiency.

These requirements can be met by the use of The Bishop-Babcock-Becker Co.'s vacuum system with any steam heating plant that is correctly designed and properly installed.

BUFFALO FAN SYSTEM OF HEATING

Why the Fan Engine Steam Costs Nothing; Air Washing and Moistening; Purifying the Air by the System of the Buffalo Forge Co.

PRIMARILY the fan system of heating is an arrangement whereby air is drawn over a radiating surface, and heated, and afterwards distributed through ducts to all parts of the building. It is, in fact, also a ventilating system because the air which carries the heat, is also the medium necessary to keep the atmosphere pure and healthful for the occupants.

There are 2 general types of Buffalo fans, the Conoidal and Steel Plate. The Conoidal is a multiblade fan, with a conical shape blast wheel giving a rigid construction. The steel plate fan differs from the Conoidal primarily in the construction of the blast wheel, which is more like a paddle wheel. The housing takes more head room but the first cost is not so great.

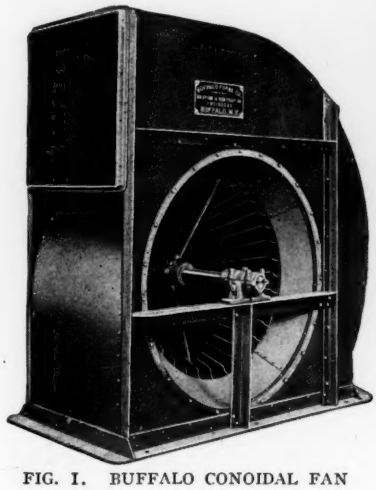


FIG. 1. BUFFALO CONOIDAL FAN

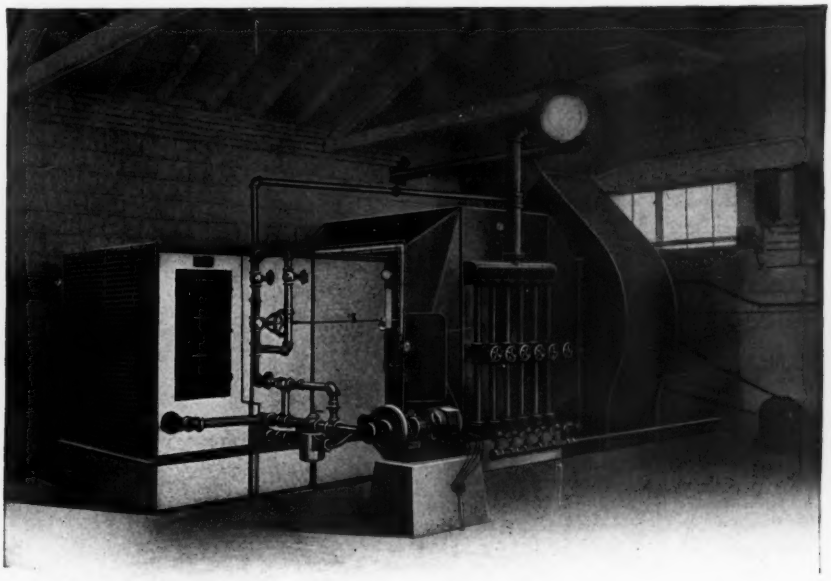


FIG. 3. AIR WASHER INSTALLATION FOR SILK MILL

Exhaust from Engine

AS a rule, the fan is driven by a direct-connected engine, and the exhaust steam from the engine is used in the heater coils, which is more economical, even, than running the engine condensing and using live steam in the coils for heating purposes. The water rate of a compound Corliss engine at full load is about 20 lb. per horsepower-hour noncondensing, and 14 lb. condensing; so that the water rate is 30 per cent less when running condensing, than when noncondensing. The amount of heat available in the exhaust steam when running noncondensing is about 80 per cent. Hence, we see that the saving of steam running condensing is only 6 lb., while the heat available in the exhaust steam would save 16 lb. per horsepower-hour; and therefore a saving of 10 lb. of steam could be made by operating noncondensing and using the steam in the heater, if all the steam available could be uti-

lized. We also see that there would be saving so long as more than 38 per cent of exhaust steam was utilized in the heater. With less economical engines, the saving made by running noncondensing and utilizing the exhaust steam is greater.

The heater sections consist of cast-iron manifold bases into which 1-in. pipes are screwed; so as to bring the air in passing through the heater into intimate contact with the heating surfaces. Five or 6 sections of the proper size are ordinarily used in each installation, as it has been found from experience that the resistance to the flow of the air is excessive if a much deeper bank of coils is used.

Enough radiating surface to heat the air up to approximately 125 deg. F. is provided. Allowing for radiation losses and air changes, this is as a rule enough heat to keep the building at 70 deg. F. in the coldest weather. The actual amount of radiating surface needed in each installation, differs greatly with the construction of the building, the location and climate and

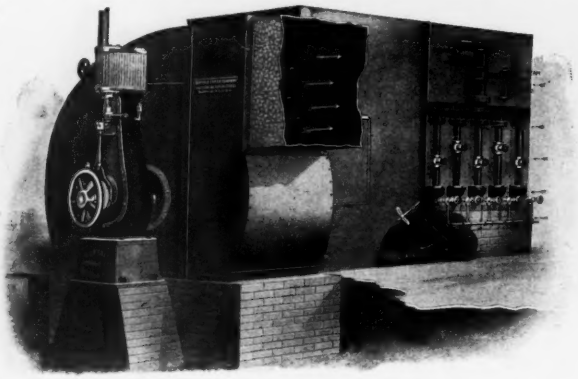


FIG. 2. FAN AND HEATER WITH COOL AIR BYPASS

therefore heating and ventilating engineers to be accurate, always figure definitely the radiation losses to determine the heating surface required.

Washing the Air

AIR washers and humidifiers, a comparatively recent and highly commendable addition to the fan system apparatus, are now specified in practically every school and public building installation. Industrial companies realize their advantages and are also installing them. They consist essentially of a spray chamber, through which the air must pass. A finely divided mist-like spray saturates the air with moisture in this chamber. Eliminator plates then catch the dirt, germs, and entrained moisture at the back end of the chamber, the air passing on in a purified condition. Excessive dryness is a characteristic of the air in cold weather and the moistening process is therefore conducive to highest working efficiency.

The "Carrier" system of humidity control is extensively used to keep the moisture content in the air constant, no matter what the outside weather conditions are. It consists of a thermostat in the spray chamber which controls a diaphragm and water heater. Air when saturated at a certain temperature always contains the same weight of moisture per cubic feet. Therefore, by keeping the temperature of saturation in the spray chamber always the same, the air is delivered with the same moisture content. The duty of the thermostat is to open the diaphragm valve and admit steam to mix with the spray water, thereby heating it and in turn heating up the air in the spray chamber to the required degree when the temperature falls below that at which it is set.

The Buffalo Fan System is sanitary, because it removes all foul and disease laden air, which authorities maintain is the cause of 40 per cent of all mortality; because it maintains a uniform temperature, and by maintaining a slight pressure prevents all drafts and

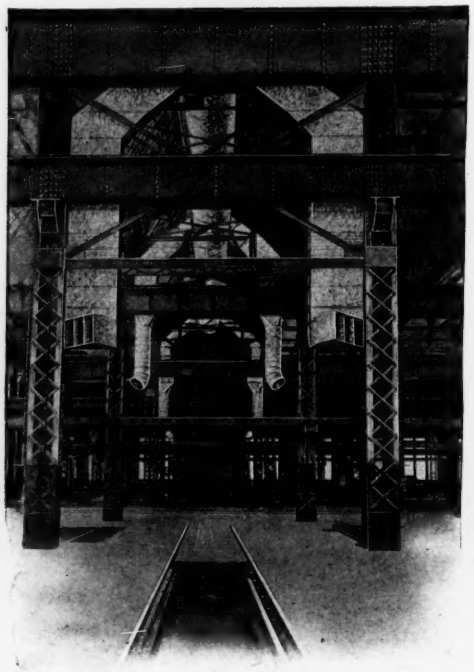


FIG. 4. OVERHEAD AIR DISTRIBUTION IN A RAILROAD SHOP

secures a warm floor; economical, because it retains all the warm air and removes the cold air at the floor line; because with it the temperature is readily and absolutely controlled either automatically or by hand, and overheating is prevented. This latter advantage is much greater than generally supposed.

Objection to the use of the fan system exists in some places on account of dust drawn in with the air and blown into the room. This has been entirely overcome by the air washing apparatus, as all traces of dust, soot, and smoke are now removed and the foulest germ laden air of the city can be made as clean and pure as that of the country.

THE DUNHAM SYSTEM OF HEATING

Vacuum Live Steam Systems of Heating With and Without Vacuum Pumps

DUNHAM Systems of heating are 2 in number. One called the Dunham Vacuum System of heating is used in large installations where high pressure steam is carried on the boilers and supplied to the heating mains through a reducing pressure valve. Another called the Dunham Vacuo-Vapor System of heating is used in residences, flats, school buildings, or in fact in any kind or size of a building where low pressure steam is carried on the boilers and delivered direct to the heating mains without the use of a reducing pressure valve.

The Dunham Vacuum System is simply a 2-pipe system of heating. By 2-pipe is meant one pipe leading from the source of steam supply to supply the radiator with steam and another pipe known as the return pipe connected to the bottom of the opposite end of the radiator from the supply, for the purpose of carrying the water of condensation and air away. The return pipe leading from each radiator combines itself into one pipe in the basement and connects to the suction of a vacuum pump. The mission of the vacuum pump is to produce a vacuum upon the return piping, drawing the water of condensation and air out of the radiators and the steam into them.

It is obvious that without some automatic apparatus intercepted between each radiator and the return line, the vacuum pump drawing on the latter would draw steam through the radiator which would in turn flow to the pump and seriously hamper its operation. It is this automatic device that distinguishes the Dunham systems of heating. It is called the Dunham Radiator Trap, shown in Fig. 1. Its mission is to open automatically for water of condensation and air and close for steam.

The operation is as follows: The corrugated metal disc seen suspended from the cover casting contains a combination of volatile fluids which respond quickly to changes in temperature. Steam surrounding this disc causes the volatile fluids to flash into a gas causing a pressure within the disc that causes it to bulge and force the valve down to seat. Water and air following at a lower temperature causes the gases previously formed by the steam to condense, the disc immediately collapses and the trap opens. The water and air immediately are sucked into the return line. Subsequent steam following the flow of water and air surrounds the disc again, the gases respond, and the trap closes.

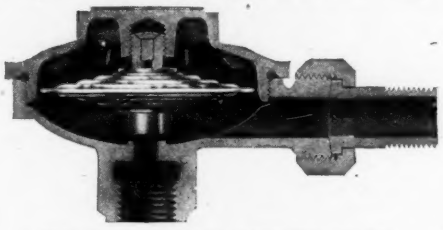


FIG. 1. DUNHAM RADIATOR TRAP

The Dunham Vacuo-Vapor System of heating is identical to the Dunham Vacuum System except for the vacuum producing apparatus at the boiler in the basement, it offers a means for making a vacuum system without the necessity for a pump. The arrangement is shown in Fig. 2.

Steam is produced in a boiler whence it flows into the radiation forcing all air ahead through the Dunham Radiator Trap on the end of the radiator and into the return line. As soon as the steam touches the disc of the trap the disc expands and closes the trap. The steam is thereby trapped and held in the radiator until it condenses, when the water of condensation flows into the trap and is passed into the return line. The water of condensation and air when it reaches the return line flows by gravity into receiving tank, the bottom of which is at least 15 in. above the water line of the boiler.

This receiving tank is connected to the boiler by 2 return pipes containing check valves as shown and one pipe loop called the equalizing pipe which connects to the top of the tank and to the boiler by a special coupling which admits of the pipe being extended down below water line of the boiler. By this arrangement, so long as the pressure in the boiler is not great enough to force water to the top of the pipe loop, there will always be a higher pressure in the boiler than in the tank. Likewise so long as the water in the boiler is sealing the bottom of the equalizing tube no steam can get into the receiving tank.

When the system is started up it will be seen that since no steam or pressure other than air pressure is

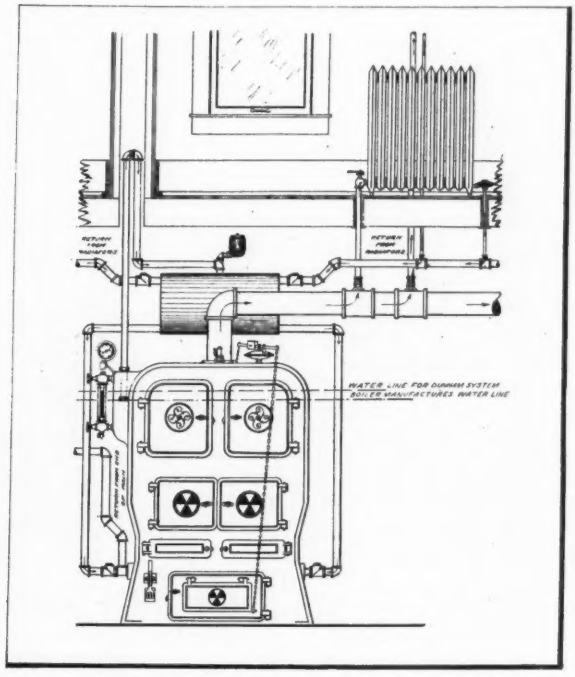


FIG. 2. TYPICAL CONNECTIONS FOR THE DUNHAM VACUO-VAPOR SYSTEM

communicated to receiving tank, any air reaching the receiving tank will be allowed to vent to the atmosphere through the Dunham Vacuo-Vapor Air Valve as shown and also that all water of condensation will be retained in the tank. As the water accumulates in the tank the water line in the boiler is continually lowering. Finally the bottom of the equalizing tube in the boiler is unsealed and steam rushes over into the tank, forming a pressure in the tank equal to that in the boiler. When this action takes place the water in the tank flows by gravity back into the boiler, seals the equalizing tube in the boiler and traps the receiving tank full of steam. The steam thus trapped condenses and forms a vacuum or pull over the entire return system of piping . This action keeps up intermittently without any attention.

By far the most important element in the Dunham systems of heating is the Dunham Radiator Trap. Upon it depends, almost wholly, the success of the system. It must not only close for steam and open for water and air, but it must also pass foreign matter that gets into the radiator without clogging up. The trap is designed to handle these conditions by having about 15 lb. of motive force.

To OBTAIN BLACK concrete mortar add 2 lb. excelsior carbon black to the mixture, for every 100 lb. of cement used. To make it dark gray, add only ½ lb. black to each 100 lb. of cement. Foundations of this color are not so hard to keep in a neat condition.

HEATING AND MECHANICAL VENTILATION

Advantages of Such Systems; Saving of Space, Cost, Trouble; Distribution of Heat Where Wanted and in Right Amounts. Systems Installed by Green Fuel Economizer Co.

MECHANICAL heating and ventilating systems are arranged in the following ways: The fan may be placed to draw the air through a heater and then force it through ducts to the various rooms, or the fan may receive cold air and force it through a steam coil heater on its way to the rooms. Again, the air coming to the fans may be tempered, that is, heated to from 72 to 75 deg. F., and the air leaving the fan may be passed in part through a steam coil, which will heat it to 150 deg. or thereabouts, and in part passed around the steam coil as shown in Fig. 1. By mixing the tempered air with the hot air, any desired temperature may be secured before the air is delivered to the rooms.

Two ducts, one for hot and one for cold air, run through the entire building, each individual outlet being connected to both flues and arranged to adjust the mixture of hot and cold air so that any temperature may be maintained in any room. Again, radiators may be placed in each of the ducts or flues going to the individual rooms and the temperature controlled by controlling the individual radiators. Another arrangement is to place the fan in the foul air duct and exhaust the air from the rooms. This arrangement is rarely used except combined with some system of forced circulation.

Supply of Heat

ADVANTAGES of the indirect system of heating are: It concentrates all steam or hot water piping in a small space where it may easily be looked after and protected from freezing. The heat transmitting surface of a hot blast heater is more effective than an equal amount of heating surface distributed through the rooms in coils or radiators.

The Positivflo Heater

THIS new and improved type of heater which has been developed after considerable experience, has positive circulation assured, the flow of the steam and of the water condensed therefrom, together with the air entering with the steam being continuous in one direction from inlet to outlet. A section of this heater consists of a bank of approximately horizontal pipes secured in vertical headers. The front header

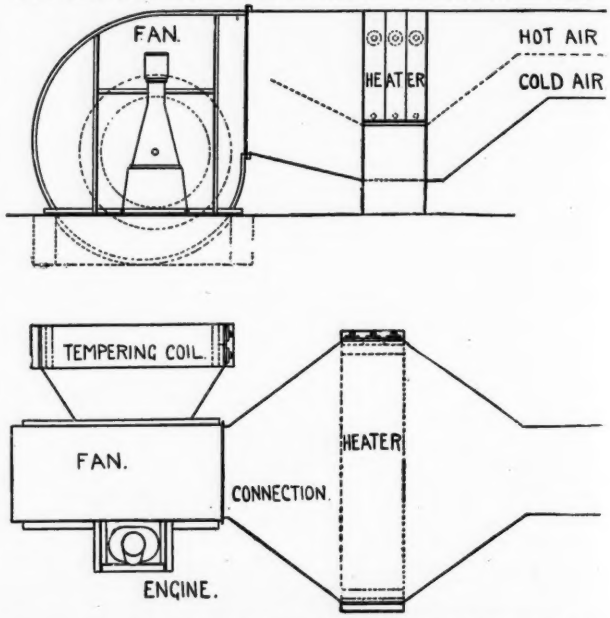


FIG. 1. FAN AND POSITIVFLO HEATERS FOR HOT AND COLD SYSTEM WITH TEMPERING COIL

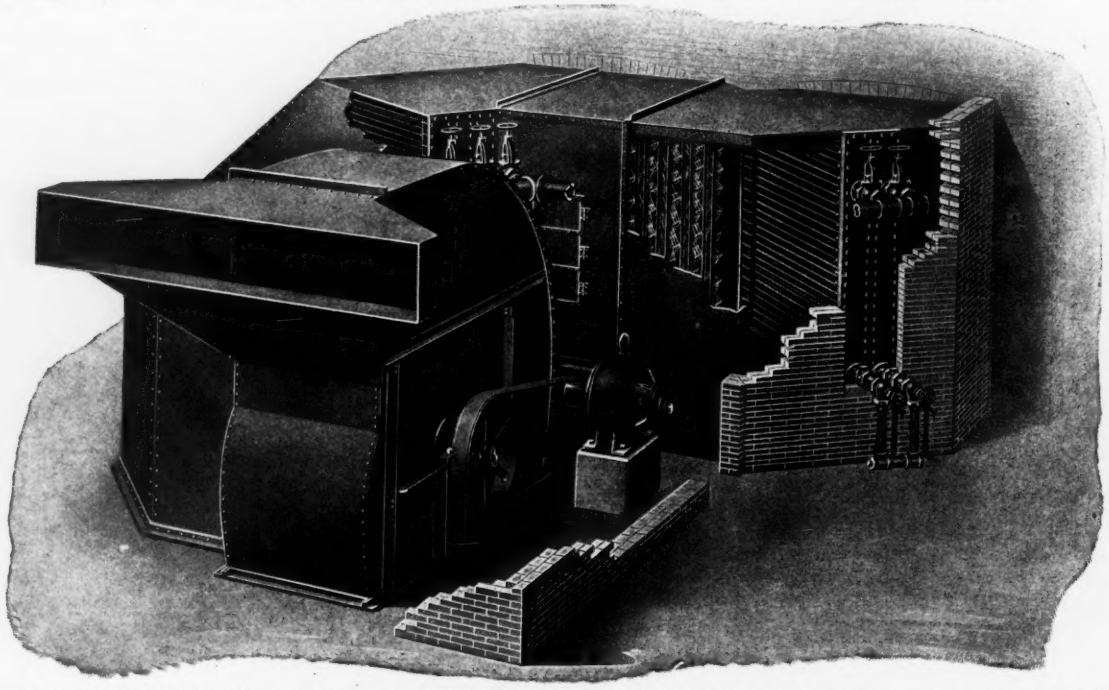


FIG. 2. COMBINATION OF AIR WASHER, HUMIDIFIER, HEATING AND VENTILATING SYSTEM, TO OCCUPY LIMITED SPACE; BUILT BY THE GREEN FUEL ECONOMIZER CO.

is divided into an upper and lower section by a division plate, while the rear header has no such division. Steam entering the upper part of the front header traverses the upper half of the bank of tubes, then passes through the rear header to the lower half of the bank of the tubes and back to the lower part of the front header.

Another point in favor of the Positivflo heater is that it may be employed in connection with hot-water system of heat distribution and may also be used for cooling air by circulating cold water through the tubes.

In the matter of inspection and repair, the tubes are absolutely straight and are nearly horizontal, so that with the front and rear header covers removed the interior of each tube is readily examined by looking in at one end and holding a candle at the opposite end. Moreover, any individual tube may be cleaned, plugged, removed or replaced without disturbing any other tube.

Covers on the headers at each end of the heater form air tight joints, one with another, hence, it is not necessary to provide covering on the sides. As the heater is usually placed on the floor or up against the ceiling, covering on only one side, either top or bottom, is required, thus saving considerably on the cost of housing.

Hot-Blast Heating

HOT-BLAST heating outfits, made up of fans and heaters, can be arranged in various combinations to suit the requirements of any particular plant, as shown in Figs. 1 and 2.

The advantages of the blow-through apparatus, Fig. 1, are that the fan handles cold air and can therefore be smaller and run at a lower speed than can a draw-through fan. On the other hand the velocity of the air leaving the fan is largely destroyed in the heater and must be recreated again at the expense of pressure when the air enters the distributing ducts. Where the fan is engine-driven, however, and the exhaust is to be condensed in the heater coils, this matters little. The blow-through equipment has a further advantage in that part of the air may be diverted before passing through the coils and used for tempering hot air from the latter or used alone, so that different rooms may be maintained at different temperatures, if desired.

Combined draw-through and blow-through equipments are, however, the most common in public buildings, sufficient heating surface being placed in the suction of the fan to temper the air to 70 or 80 deg. F., the heating coils possibly being followed by an air washer for removing dust and humidifying the air. After passing through the the fans the air then passes through a second set of coils, with suitable bypasses for adjusting temperatures, as required.

Complete Heating Equipment

COMPLETE heating layout for a theatre, including fans, Positivflo heaters and hot air distributing ducts, is shown in Fig. 2 p. 447. The air is delivered uniformly throughout the building, through the floor and walls and through numerous outlets in halls, corridors, ticket offices, etc. An entirely independent outfit is provided for the stage, which can therefore be heated independently for rehearsals or maintained at a different temperature from that of the house during performances, to suit requirements.

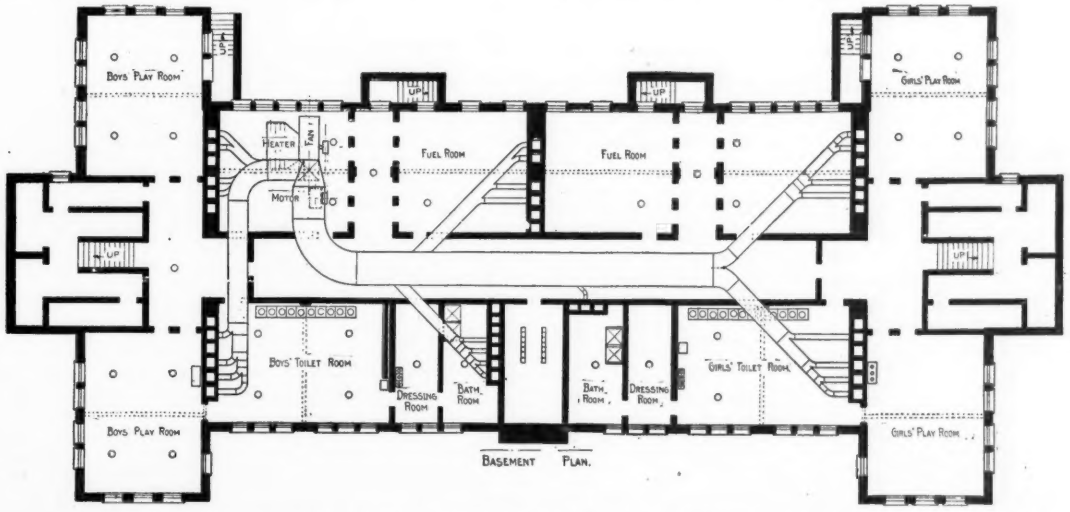


FIG. 3. BASEMENT OF LARGE SCHOOL FITTED WITH GREEN HEATING AND VENTILATING SYSTEM

A well balanced heating equipment for a modern school building is shown in Fig. 3. The Green Positivflo heater and motor driven fan are situated in the basement and the air is distributed by a large trunk line to risers located in partitions between the rooms, where foul air ducts are also located, leading to ventilators on the roof.

Special Equipment for Manufacturing Plants

HEATING of the ordinary office building, schoolhouse or theatre resolves itself into calculating how much heat and how much fresh air are necessary, facilitated by using the tables and formulas given elsewhere in this book. But, in many manufacturing plants the problem is not so simple. For instance, in the machine room of a paper mill several tons of moisture a day are thrown into the atmosphere. If no provision were made for the removal of this moisture, it would condense on the skylight and walls and fall back into the paper machines, spoiling the material. The capacity of air for carrying moisture is much greater as the temperature of the air rises and the proper quantity and temperature of air to take up this moisture, and then discharge it to the outside atmosphere without condensation, is easily calculated.

Foundries form another class of buildings difficult to heat and ventilate, for, like paper mills, there are large quantities of vapor arising from the moulds when pouring, as well as large volumes of smoke and obnoxious gases.

In a typical foundry installation the hot air is distributed through galvanized iron ducts, and instead of being delivered from spouts near the roof of the foundry, where it would immediately rise to the skylights and dissipate its heat to the atmosphere, the hot air is directed downward and delivered near the floor and at the localities where it is wanted.

Fresh air is thus delivered where it is needed by the workmen and the vapors and gases given off from the moulds are forced to the roof and out through the ventilators. As a temperature of not more than fifty or sixty degrees is required in foundries in zero weather, this hot air system is really the most economical to use.

Another novel feature of this installation is the use of outlets over all doors, so that if a door is suddenly opened, the cool air rushing in from the outside is tempered by warm air before it has proceeded far.

THE PAUL HEATING SYSTEM

Principle of Operating by Withdrawing Air, and Connections for One and Two Pipe Systems

By S. E. Balcom

IN explaining and describing the "Paul" Heating System a few of the principles of steam heating with low-pressure steam will be required to be given.

One of the worst impediments to the flow of steam at low pressure is the pressure of air in the pipes and radiators. Water can be gotten rid of by gravity

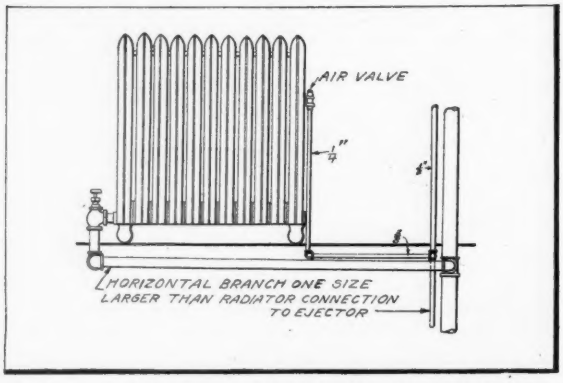


FIG. 2. PAUL SYSTEM CONNECTIONS TO SINGLE PIPE RADIATOR

when the pressure in the returns is the same or less than the pressure in the main supply pipe, but air, though it is heavier than the steam at the same pressure, needs to be taken away at a little higher point in the radiator than the water of condensation.

Taking Out Air

THE Paul System has to do with this part of the problem almost entirely, as it may be attached to any kind of a gravity system, one pipe or two pipe. I do not think it is strictly a vacuum system, as the partial vacuum is not supposed to affect the radiator unless it is shut off or just filling with steam.

With a low-pressure system, the air which is already in a cold radiator will prevent the steam from entering the radiator, consequently the radiator remains cold, no steam will condense and heat is not given off. But if there is a pressure of 1 or 2 lb. or even less in the entering steam, the air may be forced out by this pressure when an air valve on the outlet side of the radiator is opened, and then steam condenses and gives out heat. The water falls by gravity down the return pipe to the receiver or boiler, depending on whether it is a large or small system, or low-pressure boilers or not.

It requires but little pressure above the atmosphere to drive the air out of one radiator, but when there are a great many radiators and some of them at a long distance from the source of supply, the pressure needs to be somewhat higher on account of loss by friction in sending a quantity of steam long distances, that is, when you have a pressure of 5 lb. at the boiler or exhaust pipe of the engine, supplying heat, the chances are that the pressure at the farthest radiator would be considerably less than 5 lb., so that in order to circulate steam in a gravity system at low pressure, it requires in the supply pipe more or less back pressure of the steam above

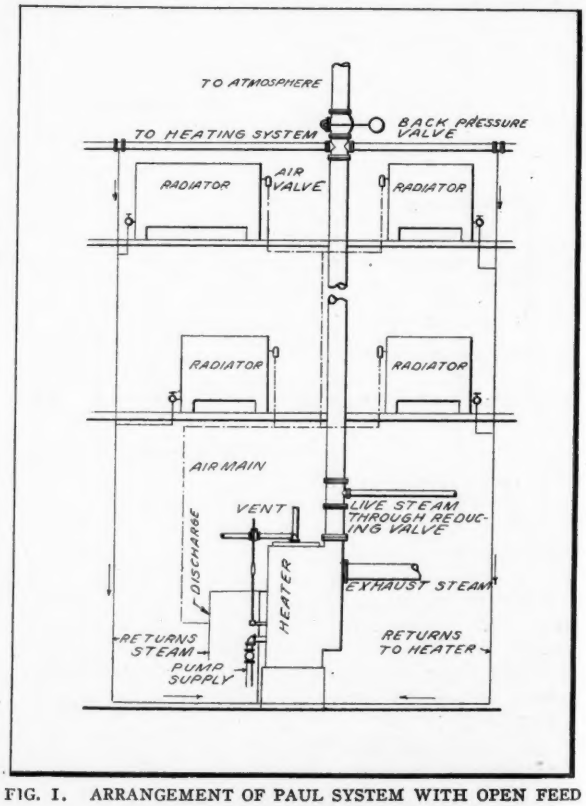


FIG. 1. ARRANGEMENT OF PAUL SYSTEM WITH OPEN FEED HEATER, USING EXHAUST STEAM

the atmosphere, and if the supply pipe is the exhaust pipe of an engine, it means loss of power at the engine or more steam consumption per horsepower.

Description

HOW, the Paul people take the one or 2-pipe gravity system and put on Paul air valves, leading pipes from them to a steam exhauster or ejector at the boiler room or any convenient point in the basement, as indicated in Fig. 1, taken from the catalog of the Harrison Safety Boiler Works.

Air valves are the thermostatic carbon plug air valves such as the Jenkins Bros., only that the Paul air valves are connected so that they cannot be regulated without taking a union apart, the point being that the engineer

should be the one to regulate them and that Tom, Dick, and Harry should not meddle with them.

By starting the ejector just before the steam is turned on in the morning, the air is exhausted partially from the radiators and a vacuum of 5 to 15 in. is induced in the air pipe and radiator. This gives a pressure to the steam, that is, it takes away back pressure so that there is a difference of pressure between the radiator and the supply so that steam flows into the radiator freely even though the gage pressure on the heating supply is zero.

When the radiator is filled with steam, and the air valve is hot, it closes and the steam condenses, causing a partial vacuum and leaving room for more steam, which flows in easily and fills the space, and any air which comes along with the steam is drawn out at the air valves as soon as it collects, as when air collects the air valve cools and opens enough to let the air into the air pipe from which the ejector takes it away. The ejector is supposed to be working all of the time, keeping a vacuum of 5 to 15 in. in the air pipe, and as the air valves close when steam comes to them, no steam is wasted.

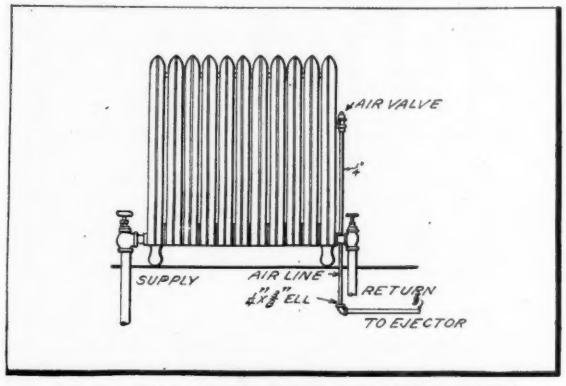


FIG. 3. PAUL CONNECTIONS FOR 2-PIPE SYSTEM

Every radiator air valve is connected by a ¼-in. pipe to the air riser which is generally ¼ or ⅜-in. depending on how many radiators are connected to it. The branch pipes in the basement are ⅜-in. and the main air pipe ¾-in. Air pipes occasionally plug up with pipe scale the same as any pipe, but not often, as there should be nothing but warm air and a little vapor pass through them. The air valves might trouble a little by collecting grease from the exhaust steam from the engine, but the trouble is slight; probably twice a year being often enough to clean them, as they are above the water line of the radiator and the the grease can not get to them much. I have heard of cases where the air valves were stuck up and stopped with grease, but it was where they had not had proper attention. Any system needs attention. Of course, if the air valves leak, they should be repaired or adjusted, because the steam leaking through will go to waste and spoil the vacuum in the air pipe, and put more work on the ejector.

A leaky air valve may easily be found by placing the hand on the air pipe and if it is hot, there must be too much steam leaking through. The air valves should be adjusted so that the air pipe will not be hot much more than 6 in. beyond the air valve.

Exhausters

THESE are like an ordinary steam ejector with a small nozzle, the diameter of the hole in the nozzle being about ⅛ in. One exhauster is able to take care of 500 sq. ft. of radiation and they are generally put in so that either one or 2 may be used, dependent on the temperature of the weather; if it is cold, both are used, creating a slightly higher vacuum.

The vacuum needed is just enough to clear the radiators of air and if all are hot, the vacuum is high enough. Any higher vacuum would mean wasting steam by the exhauster as a higher vacuum would require more steam to create it.

The discharge pipe of the exhauster should be led to the receiver which takes the returns from the radiators, and this receiver being vented at the top, the air is discharged that way and the condensation from the steam jet of the exhauster is taken back into the boiler. Sometimes the discharge of the exhauster is piped to the sewer, which of course lets the stem of the jet go to waste, and that being clean steam directly from the boiler, ought to be saved. The exhausters should be looked at occasionally as the nozzle will enlarge by wear after a time.

The amount of steam which one jet or exhauster will require is 30 to 150 lb. an hour, depending on whether it is run to its full capacity or not. A ⅜-in. pipe supplies the exhauster with steam and, if only low vacuum is needed, the valve on the steam pipe should be choked down, thus saving steam.

Check Valves

IN a 2-pipe system, a check valve or water seal should be on the condensation return pipe of every heating coil or radiator or at least on every 2 or 3 radiators as,

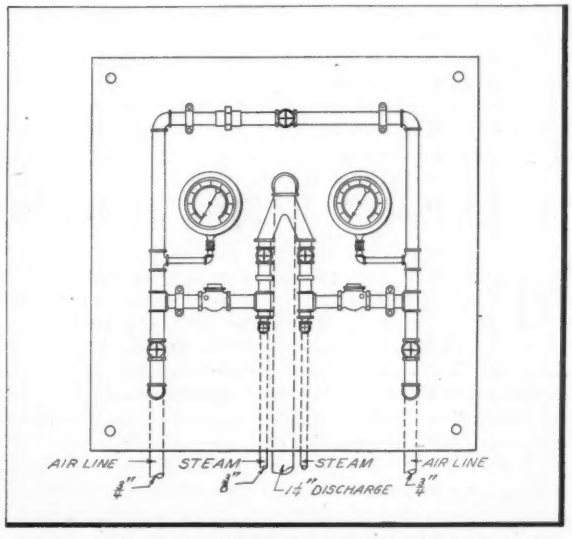


FIG. 4. FRONT ELEVATION OF PAUL EXHAUSTING SET; 2 EXHAUSTERS

if any radiator is shut off the steam will back up the return pipe from other radiators and heat the radiator which is shut off. A check valve is usually used, because a water seal of 15 ft. is an inconvenient piece of apparatus to put in. The check valves should be swing check valves and they should be as far below the bottom of the radiator as possible as it takes a little weight of water to open the check valve; if the check valve is at least 6 in. below the radiator outlet, the valve will open, if it is not too sticky with grease.

Of course, if the return pipe drops from the radiator a certain distance before it comes to another branch return, the weight of water in the drop leg might be sufficient to open the check valve even if the valve were up level with the bottom of the radiator, but it is always safer to put the check valve as low as it can be con-

veniently, because where we are dealing with small differences in pressure, a little resistance is apt to cause trouble.

Care of System

GREASE and oil should be kept out of a heating system if possible; a little will get in even with the best of care, but with a good separator well drained, that little will not bother much.

The air valves should be adjusted when hot because, if they are closed when cold, the expansion of the carbon plug will crush the seats and spoil them, but if they are closed so that they just shut off the steam when hot, they will open when cold.

When at any time a radiator or coil does not heat, disconnect the pipe from the air valve and see whether you have a partial vacuum on the air pipe, and if not, the air pipe must be plugged somewhere between that radiator and the main air pipe, and if no other radiators are giving trouble, the obstruction must be in that branch, but if other radiators are troubling also, do the same at the others and in that way trace the trouble.

When a 2-pipe system is used, the return pipes lead to a common return and into an open or vented receiver, and the discharge of the exhauster may be led to that, thus saving the steam and letting out the air. If the returns run to an open heater, the discharge may be piped to a pipe of a little larger diameter than the discharge pipe and that pipe run to the heater and also up to the roof for vent. That is, a stand pipe should be run from the heater up and out doors somewhere to vent off the air.

The accompanying illustrations, Figs. 2-4, from Principles of Steam Heating, by Wm. G. Snow, show the view of a 2-pipe system and also of the exhausting arrangement. The only reason for having 2 exhausters is economy; run 1 or 2 as required by coldness of weather.

TOOLS FOR CLEANING BOILERS*

By J. W. Hubbard

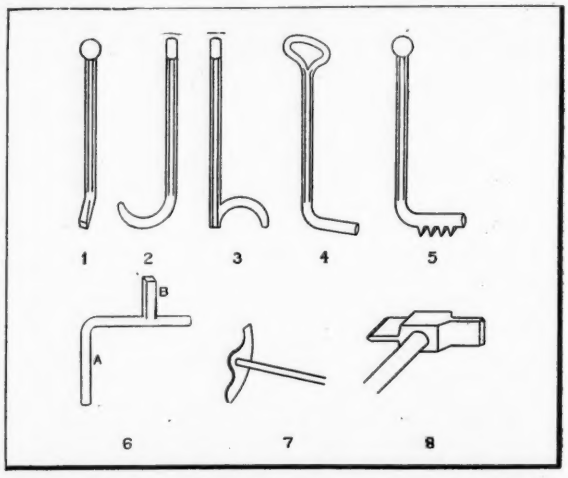
MUCH has been published regarding the need of keeping boilers clean, but aside from descriptions of patented devices, little has been told of the forms of implements suitable for the purpose of cleaning. Tools described here are not new but are described with the hope that more engineers may become acquainted with them and learn of their usefulness in keeping boilers clean and free from scale.

Tool No. 1 is of general utility. The amount of angle near the point and the length of the handle can be varied to meet the requirements of each particular case. The chisel point should be ground sharp and tempered hard. The knob on the end forms a convenient handle, and adds weight to the tool at a point that makes its use effective. The knob should be left soft so that if there is occasion to use a hammer on it, the eyes of the operator will not be endangered by flying particles. All portions of the tube sheet, with the exception of the small surfaces on it between vertically adjacent tubes, can usually be reached for cleaning with this tool. One-half inch hexagonal steel is the proper size stock of which to form this implement.

Tools represented by Nos. 2, 3, and 4 are scrapers for removing the scale from the tubes and should be made of ½-in. hexagonal stock. Numbers 2 and 3 should be sharpened on the concave edges and No. 4 on both edges. By leaving off the loop handle on No. 4 and forming it of ⅝-in. steel, the cutting edge can be driven along the tops of the different rows of tubes against the head, breaking down a part of the scale which cannot be reached by No. 1. With one edge formed, as illustrated in No. 5, it is especially effective for this use.

Tool No. 6 may be used for breaking away heavy scale that may bridge the horizontal space between the tubes away from the heads. This is inserted in the vertical space between the tubes and is turned by the handle A, which carries the projecting end B around in a horizontal plane and forces out the scale between the tubes. The leg B should, of course, be made of such size that it will pass easily between the tubes at points where no scale is adhering.

No. 7 is a convenient form of hoe, for removing loose scale or deposit from the bottom of the shell of horizontal tubular boilers. This tool is particularly convenient for this purpose where the boiler is only provided with a hand-hole communicating with the portion of the shell below the tubes. The points of the blade are cut away so



1, CHISEL FOR SCALE REMOVAL; 2, 3, 4, SCALE SCRAPERS FOR TUBES; 5, SCALE BREAKER; 6, FOR BREAKING SCALE FROM BETWEEN TUBES; 7, SHAPED HOE FOR BOTTOM OF TUBULAR BOILER; 8, HAMMER FOR CLEANING PLATES

that they may pass under the lower tubes at the side of the boiler and the edge of the blade is made to conform to the curvature of the boiler shell. This latter requirement is important, in order to make the use of this tool effective. The handle should be made of ¾-in. pipe and the blade of ¼-in. plate steel. The hole in the blade for the attachment of the handle should be tapped and the pipe screwed into it and held fast with a jam nut.

If the space in front of the boiler is sufficient, it is preferable to have the handle of this hoe made of one piece of pipe, but if this is not practicable, it may be made of 2 or more pieces as required. When working with this hoe, it is often convenient to tie on the handle near the blade a small piece of waste saturated with oil, setting this on fire to light up the interior of the boiler in order to see where to reach for loose material.

A hammer of the type illustrated in No. 8 is very useful for cleaning plates, but for jarring the scale loose from the tubes, a flat-faced hammer should be used.

There are, of course, cases where the thorough cleaning of a boiler is impossible owing to either the hardness of the scale or inaccessibility due to design.

In using the tools here illustrated or any others for a similar purpose, the greatest care should be exercised that the tubes or other portions of the boiler are not injured in the process of cleaning.

*From The Locomotive.

EUROPEAN POWER PLANT PROGRESS

By Francis G. Wickware

WATER GAS AS AN ENGINE FUEL

COMPLETE success in the operation of gas engines of ordinary types on water gas is one of the recent European achievements in the gas-power field. Water gas, which is the gas most widely used for illuminating purposes in the United States, is essentially a mixture of carbon monoxide and hydrogen formed by the reaction $H_2O+C=CO+H_2$ when steam is led over incandenscent coke.

This reaction absorbs a large amount of heat and rapidly cools the bed of fuel to a point below which the action ceases. As much heat as possible is supplied in the steam itself, by superheating to a high temperature, but ordinarily the heat in the fuel bed must be regenerated at intervals by interrupting the steam supply and admitting air. Hence the production of water gas is intermittent, the usual cycle being about 6 min. gas formation followed by 2 min. regeneration.

It is reported in a recent issue of Die Gasmotorentechnick that a special type of water-gas generator is now in use, in which a large amount of heat is stored up in the coke bed by employing a hot-air blast for regeneration. The hot air acts on the coke from all sides, and during the period of regeneration the carbon is burned almost completely to CO_2, which is allowed to escape to a stack. The chimney gases during regeneration have the approximate composition CO_2 17.2 per cent, CO 5.5 per cent, O 0.4 per cent, and the rest nitrogen. With the hot blast the time required for regeneration is very short, not more than 1 minute for 7 minutes of gas production.

As it comes from the generator the water gas contains sulphur (in the form of hydrogen sulphide), and small particles of ash and silicon dust. To prevent corrosion and abrasion of the engine cylinder, these impurities must be completely removed.

The gas is first washed in a scrubber, which removes particles of ash and lowers the temperature of the gas. It is next led through a purifier containing iron ore, with which all the sulphur combines, and finally the last traces of dust are removed by passing the gas through a layer of fine sawdust, after which it is led to a gasometer from which the engine is supplied.

The sawdust and iron ore are serviceable as purifying agents for only 5 to 6 weeks. Hence a constant watch should be kept on the purity of the gas, for which simple tests are available. Ash and dust are readily intercepted and are easy of detection against a dark background. The products of combustion of a gas containing hydrogen sulphide produce a dark brown stain on a paper soaked in lead acetate solution. If the tests give positive results, the purifiers must be recharged.

One difficulty in the employment of water gas in an engine fitted for incandescent tube ignition is the liability of the fuel to pre-ignition. This can be overcome by the use of a very short tube. The calorific value of the gas is about 280 B.t.u. per cu. ft., the temperature of the flame about 3100 deg. F., and the temperature of the exhaust gases about 750 deg. F. The consumption of gas per horsepower is about 10.6 cu. ft. About 66 per cent of the heat is utilized, and the overall efficiency of the water-gas plant is about 43 per cent.

The total annual operating cost of a water-gas plant in Germany, with a capacity of 1308 cu. yd. per day for 300 days in the year, is $2275. The gas costs therefore, about 0.575 cent per cu. yd., and the cost per horsepower hour is about 0.7 cent. From city gas plants gas can be purchased for about 1.9 cents per cu. yd., or 2.25 cents per horsepower-hour. In many plants in Germany water-gas engines have been operating on tube and spark ignition for as long as 3 years without the slightest appearance of trouble.

A NEW METHOD OF SMOKE PREVENTION

THE Bender-Lehmann system of smoke consumption for steam boilers, a new method which is being applied extensively and with excellent results in German power plants and in torpedo boats of the German Navy, is described in a recent issue of the Journal fur Gasbeleuchtung und Wasserversorgung. It is based on the well known reaction between superheated steam and incandescent coal, which is employed to effect complete combustion of the volatile smoke-forming ingredients of the coal, while the mechanical suppression of solid particles of soot and ash is effected by the manner in which the steam is introduced into the combustion chamber.

Hydrogen and CO formed by the reaction between the steam and glowing coal unite with the oxygen of the air passing through the grate, burning in the combustion chamber with a very hot flame. The intense heat dissociates a part of the steam into hydrogen and oxygen. The hydrogen immediately recombines with oxygen of the air, while the oxygen in its nascent state effects complete combustion of the hydrocarbons which under ordinary conditions escape in the form of smoke.

To this purely chemical function of the steam is added a mechanical function. The soot and ash particles rising from the grate are met by jets of steam blown under high pressure obliquely downward into the combustion chamber and are thus prevented from reaching the chimney. In addition to suppressing smoke, the steam jets have their usual effect on the draft and stimulate combustion by increasing the air supply to the furnace.

The metal nozzles employed in the earlier Bender-Lehmann apparatus were so rapidly oxidized under the exacting temperature conditions that uniform regulation of the steam supply was practically impossible. A further difficulty was that they became seriously clogged during periods of shut-down of the boiler.

Both these difficulties have been overcome in a new construction which employes a nozzle tip of a refractory and unoxidizable material connected with the steam supply pipe by a device which compensates for the difference between the coefficients of expansion of the two.

In addition to securing practically smokeless combustion, the system effects a saving in fuel of 5 to 10 per cent. The latter figure has been attained in actual test, not only is the total quantity of smoke formed very materially reduced, but smoke is practically suppressed during firing periods. Clouds of black smoke escaping during firing when the apparatus is not in

operation immediately disappear when the steam is turned on. The efficiency of the system is vouched for by the German bureau which administers the smoke prevention ordinances. While perfection is not claimed for the system, it is recommended as an important step toward simple and inexpensive smoke suppression.

A NEW LUBRICANT TESTING MACHINE

A NEW machine designed to obviate the uncertainties of testing lubricants by physical and chemical experiments with small samples and to disclose their characteristics under conditions of practical operation has been described recently before the Berlin Section of the Verein Deutscher Ingenieure. The "Ossag" machine gives positive and

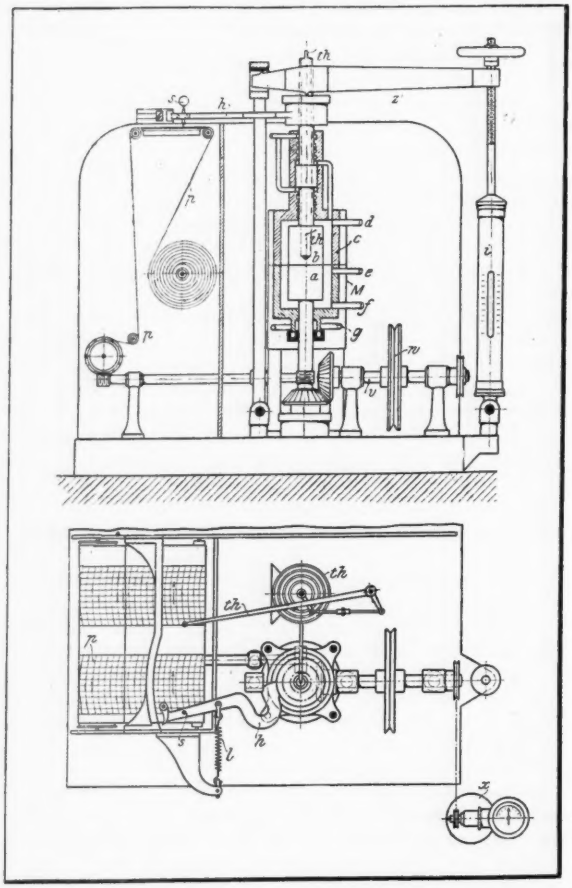


FIG. 1. ELEVATION AND PLAN OF LUBRICANT TESTING MACHINE. a AND b TESTING SURFACES; d, e AND f, STEAM AND WATER PIPES; g, GAS BURNER; h, LEVER; i, SPRING BALANCE FOR LOAD MEASUREMENT; l, CALIBRATED SPRING; p, PAPER; s, STYLUS; th, THERMOGRAPH; v, DRIVING SHAFT; n, DRIVING PULLEY; z, LEVER FOR APPLYING LOAD; x, TACHOMETER

reliable data of the practical value of all kinds of lubricants, which may be subjected to any desired load up to 700 lb. per sq. in., and to any desired speed of rotation up to 1500 r.p.m.

The machine is shown in elevation and plan in Fig. 1. The lubricant to be tested is introduced between the 2 plane surfaces a and b, the former of which is revolved through the gearing shown at the bottom of the diagram. The motion communicated by friction to the surface b is transmitted through a calibrated spring l and a lever to a stylus s, which automatically traces the characteristic curve of the lubricant on a

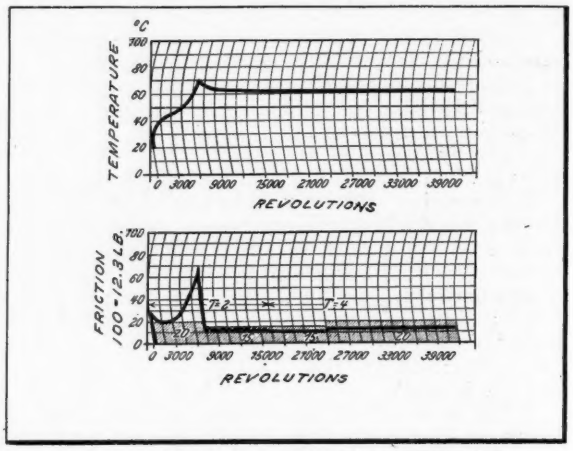


FIG. 2. RECORD OF A TEST OF MACHINE OIL

strip of paper which moves in conjunction with the driving mechanism.

One special advantage claimed for the Ossag machine is that cylinder oils may be subjected, while under test, to the action of superheated or saturated steam. For generating the necessary steam a small boiler and a superheater which may be placed in or out of operation as desired are supplied.

The character of the records obtained is shown in Figs. 2 and 3. Figure 2 is the record of a test of a ma-

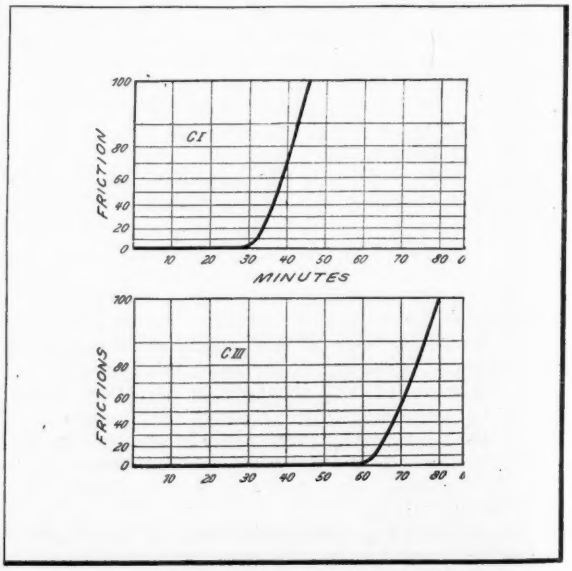


FIG. 3. RECORD OF TESTS OF CYLINDER OILS

chine oil, supplied at the rate of 2 drops per minute, which could not sustain a load of 280 lb. per sq. in. at 575 r.p.m. Reduction of the load to 210 lb. per sq. in. reduced the friction to a point which indicated the suitability of the oil to this load. By increasing the rate of supply to 4 drops per minute, the load was raised to 280 lb. per sq. in. without affecting the efficiency of the lubricant.

Figure 3 records comparative tests of 2 cylinder oils, subjected to a temperature of 250 degrees C. (482 deg. F.). The points at which the curve begins to ascend indicate the points at which destruction of the lubricating power of the oils begins. The highest points, marked 100, indicate complete destruction of the oils. Oil CI preserved its lubricating power for 30 minutes, and oil CIII for 62 minutes. Oil CI was destroyed at the end of 45 minutes, and oil CIII at the end of 78 minutes. It appears, therefore, that the consumption of CI would be double that of CIII under the same conditions and in the same time.

SEGREGATION OF STEEL

Mr. Huston Explains Some Points Not Made Clear in the Report of His Paper Read at New Orleans

I THANK you for the notice you have given in your issue of April 1, of the article I presented at the American Boiler Makers' Association Convention in New Orleans.

I beg leave, however, to suggest that there are several errors, which your correspondent has gotten into his article, which would cause misunderstanding, as he has introduced part of the oral discussion, which followed presentation of my article, into his report and evidently has not quite caught the intent of my remarks.

I think it would give more accurate understanding of my meaning and the information I endeavored to convey in the after discussion if it had read as follows:

As to the segregation of steel, although the average composition as shown by test from ladle may be as desired, variation in the composition will occur. This is due to the expulsion of the foreign elements from the steel as it solidifies and to the action of the gases which are given off between the chilled portion of the metal and the molten part. At first these rise to the surface and escape, causing a circulation in the mould up around the edges and down in the center. This results in a pretty thorough mixing of the expelled carbon and other metaloids throughout the remaining molten portion of the material in the mould, thus offsetting to a considerable extent the natural tendency of these metaloids to float to the top, which they would otherwise do by reason of their lighter specific gravity.

As the metal cools, it becomes too thick for the gas bubbles to force their way up, and they are caught in the metal, forming a layer of slightly porous metal a little distance in from the entire surface of the ingot; the location of this zone of slightly porous metal, as to its distance in from the surface of the ingot, is controlled by the furnaceman, who watches the slag and the temperature at which the melted steel is poured, in order to secure the location of this layer of gas bubbles at a point where it will be the least detrimental to the working qualities and service condition of the product, by keeping the gas ring as far away from the surface of the ingot as possible and at the same time to avoid collecting them in large pockets at the center of the ingot or elsewhere. The best location seems to be usually at 1½ to 2½ in. from the surface.

During the processes of reheating and rolling, these pores are closed up, but the uneven distribution of carbon through the billet is not eliminated, so that test pieces from the part of the plate representing the middle of the ingot show decidedly different composition and test from those taken near the outside edges as well as some difference also between the top and bottom of the portions of the ingot away from the edges, the metal representing the outer edges of the ingot, being almost entirely uniform with the exception that in small, thin billets, where the metal chills so quickly that the mixing effect cannot be so fully secured, there is some difference in hardness between the top and the bottom of the outside edges. Carbon, phosphorous and sulphur are the elements mostly affected by segregation, and carbon, phosphorous and manganese are the ones that have the most effect on the hardness of the steel, sulphur makes a difference in the readiness of hot working in flanging and forming, but Mr. Huston stated that, so far as his experience went, this element does not affect the strength and toughness of the steel when cold or at the ordinary service temperatures. One set of tests on a plate 335 by 94 by 29/32 in. rolled from an ingot 48 by 20 in. and weighing 11,000 lb. varied from carbon 0.5 and a breaking stress of 78,100 lb. at the top center to carbon 0.2 and stress 59,500 lb. at one corner of the bottom; the ladle test specimen showed carbon 0.26.

In another plate rolled to ¼ in. gage from a billet 26 by 12, weighing 2800 lb. showed at the center plane of the ingot for the middle top, carbon 0.3, manganese 0.46, sulphur 0.037, phosphorous 0.022, breaking stress 62,740 lb.; for the corner bottom, carbon 0.16, manganese 0.42, sulphur 0.02, phosphorous 0.024, breaking stress 55,900 lb. The ladle test showed carbon 0.19.

Numerous other tests were given, also microphotographs showing the construction of the metal at different parts of the ingot.

I should be glad if you would make this correction in some way so as to keep a wrong impression from maintaining in the minds of those who may have read this article and drawn their conclusions therefrom.

The whole trend of my article was to show that a difference in hardness, caused by lack of uniform distribution of the hardening metaloids, was not distributed in the way it was usually understood to be and that cropping to any definite percentage from the top of the ingot would not remove the segregation of these metaloids in steel, and that the richest zone of segregation in this class of steel did not incline to work toward the central axis, but was located instead just in or inside of this layer of little gas holes, because of the failure of circulation just toward the last after the molten metal had become too thick to mix freely what was squeezed out by the solidifying action just at this stage.

You will also notice that you have printed silicon in the place where phosphorous should be in enumerating the hardening elements, as I stated that silicon is not present in any appreciable quantity in the class of steel usually made into boiler plate.

Chas. L. Huston.

THE FOLLOWING INCIDENT HAPPENING RECENTLY in the city of Warren, O., serves to demonstrate the sturdiness of street series Mazda lamps with drawn wire filaments. A runaway horse attached to a heavy carriage ran into one of the lighting standards that within the past year have been installed along the streets of that city. The vehicle struck the standard with such force that the 3 globes enclosing the lamps were shattered. The wagon hooked onto the post and was stopped while the horse broke loose on account of the cross-bar breaking. It was found afterwards that not one of the 3 lamps on the standard was injured in spite of the fact that the accident occurred about 3 o'clock in the afternoon when the lamps were not burning.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

ALTERNATING CURRENT GENERATORS

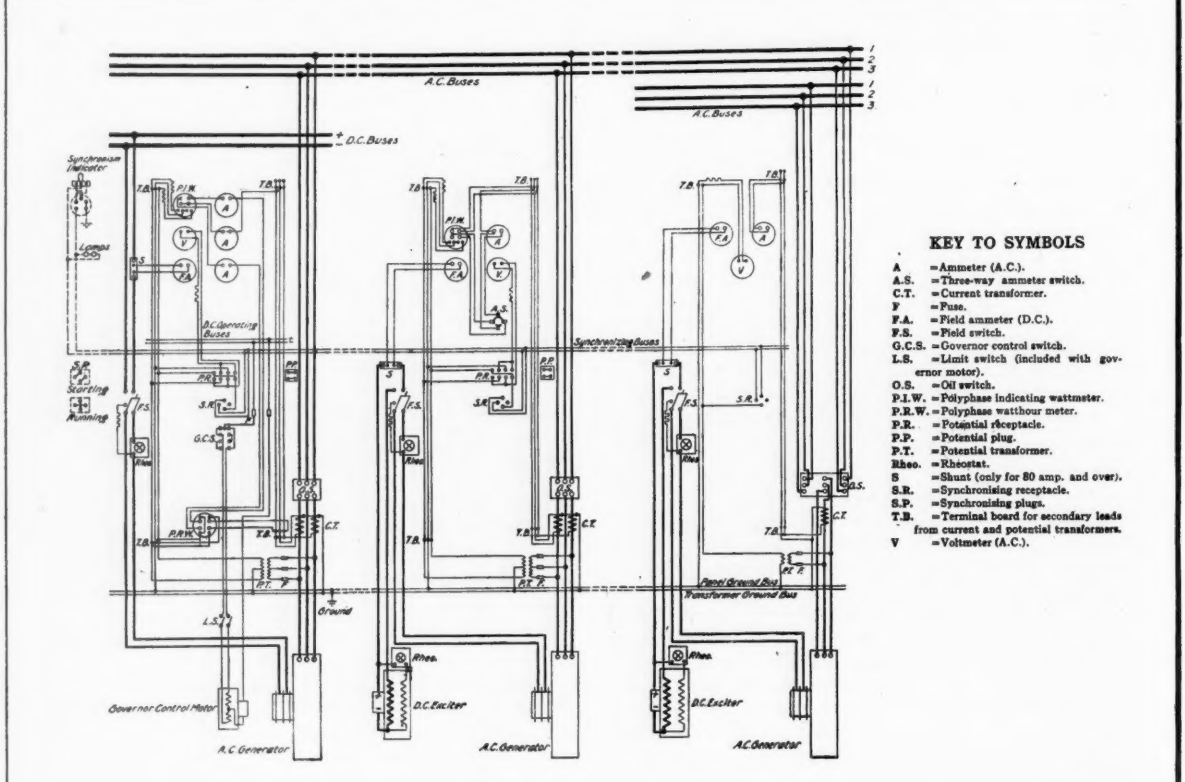
Installation, Operation and Care

By Carl D. Knight

ALTERNATING CURRENT GENERATORS may be divided into 2 general classes, depending upon the mechanical construction. These classes are the revolving armature and tne revolving field. The revolving armature type of machine at the present time is seldom manufactured and only in comparatively small sizes. The great advantage of the revolving field machine is the absence of high voltages at the slip rings and the reduction of slip ring troubles, as well as rendering it possible better to insulate the machine, and reduce the danger to the attendant to a minimum.

Excitation or field current for all alternators is provided from a direct current generator. This direct current generator is usually, but not necessarily, a machine used solely for this purpose. The method of driving exciters, as these direct current generators are called, varies with the size of the station in which they are used and with the speed and size of the alternator itself.

In the larger power houses the exciters are often driven by a prime mover, either a water wheel or a steam engine, and some times by an electric motor. If a motor driven exciter is used some means must be provided to excite the alternator fields when the alternator is first started, as there is then no power to drive the motor. A steam or water wheel driven exciter is often installed for emergency purposes only. Exciters for high speed belt driven alternators are often built onto the



THREE-PHASE GENERATOR DIAGRAM OF CONNECTIONS, COURTESY OF GENERAL ELECTRIC CO.

alternator shaft or direct connected to it. This forms a very neat and simple combination but is rather more expensive.

Most common practice in small plants is to belt the exciter to the alternator. This has the advantage of cheapness, allowing a higher speed and consequently a smaller exciter to be used than would be possible in the case just mentioned. The belted exciter may be mounted on the floor near the alternator, on the wall of the room, or even on the ceiling. If a belt driven exciter is to be mounted on a wooden floor as is often done, care should be taken that the floor is well supported from below. There will usually be some vibration from belted machines and the foundations should always be such as to reduce it to a minimum.

Direct connected alternators having 2 bearings and their own bed plate to which the stationary parts, either armature or field, and the bearing supports are bolted, should be lined up to the engine very carefully. Such combinations should always be located on masonry foundations and flexible couplings should be used in preference to rigid couplings.

Direct connected alternators resting on common bed plates with the engines, should not have the stationary field or armature placed in the final location until the revolving element, with its shaft and bearings have been carefully located with respect to the engine shaft and firmly fastened in position. The stationary part may now be located, making sure before fastening in position, that the air gap, that is, the distance between the armature and field iron is the same at the top, bottom, each side, and on each end. This air gap may be measured conveniently with a narrow wedge of metal or hard wood.

In making the connections for any alternating current generator, the wires from the exciter armature should be brought to the clips of a double-pole single-throw switch placed on the switchboard. An ammeter and a voltmeter may or may not be used in the exciter circuit as desired, but it is better practice to use them. The rheostat for the exciter field should also be placed conveniently near. The wires from the alternator field with rheostat in series, should be connected to the blades of the switch. The wires from the armature, with circuit breakers or fuses, and ammeter in series, should be connected to the blades of the main switch.

In starting, first bring the alternator and its exciter up to normal speed. The exciter should then build up to its normal voltage. In case it does not build up, try reversing the field or throwing the brushes over a pole, but not both. It should be remembered that the exciter is subject to all the troubles of the direct-current generator, which are not included in the province of this article.

Assume that the exciter has built up, close the double pole switch connecting the exciter to the alternator field. Provided there is no trouble with the alternator it will build up at once and its voltage may be regulated by means of the exciter field rheostat. The alternator field rheostat is not ordinarily used, its resistance being left all cut out, that is, turned as far as possible in the direction marked "To raise voltage." The main switches may now be closed and the alternator placed under load.

Failure to Generate; Open Circuit in Field Winding

IF with full excitation voltage applied to the alternator field and the machine running at normal speed, there is no voltage at the armature terminals, it will indicate an open circuit in the field windings. This is more likely to occur in the connections between the field poles, and can then be easily located and repaired. Should the trouble be located in any field coil it will be necessary either to rewind it or procure a new one.

Reversal or Short Circuit of Field Poles

IF full armature voltage at no load can be obtained only by use of excessive field current, it may indicate a reversal or short circuit of one or more field poles. A resistance test should be made on the field windings, the voltage drop being read across each individual pole. A short circuited pole will show a lower resistance than the average. If the poles all show the same resistance, the polarity may be tested with a compass. The poles should be alternate north and south, but in case they are not, the faulty ones may be reversed.

The most frequent cause of short circuits in alternator field windings is the destruction of the insulation by suddenly breaking the field circuit when shutting down. This may be guarded against by connecting a discharge resistance across the field at break, or by breaking the field very slowly and drawing out the arc.

Open Circuit in the Armature Windings

IF with full exciting current in the field windings there is no voltage at the terminals of any one phase it will indicate an open circuit in that phase.

Overheating of Field and Armature

AN alternator is so designed that with a given current in the field winding, the armature running at normal speed will generate normal voltage at full load and specified power factor.

Any one of the following causes will necessitate a field current larger than normal and a consequent overheating of the field.

Short circuited field spool, generator voltage higher than normal, generator run below speed, overload, low power factor, overheating of the field windings will also cause overheating of field and armature iron.

The only remedy for overheating from the above causes is to restore normal conditions.

Overheating of the slip rings will usually be caused by excessive current, poor contact, or friction. To eliminate the last two, the rings and brushes should be kept clean and smooth by occasional polishing with fine sand paper and lubrication with a little good commutator compound or vaseline.

Armature conductors overheating will usually be found to be the result of an excessive current, due either to overload or low power factor. It may in some instances be due to conduction of heat from overheated armature iron caused by an excessive field current.

A short circuit in an armature coil will produce local overheating and can usually be located by burned insulation.

The accidental grounding of the armature winding in 2 places will result in overheating due to the local current through the grounded section.

In general alternator troubles may be avoided by exercising care in the operation of the machine. The following "don'ts" may be of service.

Don't allow oil to run on the insulation, it will destroy it in time.

Don't allow the ventilating ducts in the iron to become clogged with dirt, it will cause overheating.

MILTON P. HIGGINS, who, since their incorporation has been president of the Norton Co., and the Norton Grinding Co., passed away at his home in Worcester, Mass., recently. Mr. Higgins has been, during all his life, promient in the field of technical education, and latterly had done much to promote vocational training and half-time schools for the benefit of those wishing to enter the industries of his home state.

WESTINGHOUSE DIRECT-CURRENT TURBO GENERATORS

Single Wheel Impulse Turbine Mounted on Generator Shaft; Commutating Poles and Steel Rings Shrunk Upon Commutator Are Features of Generator

DIRECT-CURRENT, turbo generator units of small capacity, find wide application where a simple, compact, reliable generating set is desired. Many are used for exciter sets in alternating-current generating stations, for lighting and power in industrial plants and in office and apartment buildings, for storage battery charging in railway signal work, and for train lighting. They are particularly applicable for exciter service in modern generating stations where the steam pressure exceeds 125 lb. per square inch because small reciprocating engines ordinarily used for driving exciters are usually designed for pressures not greater than 125 lb. per square inch. Where the boiler pressure exceeds 125 lb. per square inch, a reducing valve must be used with such engines. Westinghouse Type T turbines operate

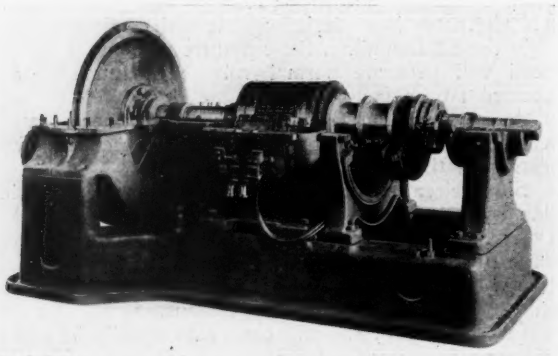


FIG. 1. A WESTINGHOUSE 100-KW., DIRECT-CURRENT TURBO GENERATOR SET WITH TOP CASING REMOVED

directly on pressures up to 200 lb. and with steam superheated to 150 deg. F.

Simplicity and reliability of this type of unit result from the few moving parts, few parts that require attention because of wear, small number of bearings to oil, and no stuffing boxes to pack. Compactness is a characteristic of turbo generators and in this respect Type T turbines meet with favor in crowded plants. Expensive foundations are not required for a turbo-generator unit of this type and the installation costs are thus reduced greatly from that of reciprocating units.

The line of Type T sets includes machines of the capacities most in demand of from 10 kw. to 200 kw. Standard voltages are 125 and 250, but three-wire generators of 125 and 250 volts are also made. The steam pressure range is from 75 to 200 lb. per square inch. Either shunt or compound wound generators can be furnished. Standard compounding is 118 volts, no load, and 125 volts, full load, or 235 no load, and 250 full load. Compounding can be varied by adjusting the shunt.

The turbine, Fig. 1, is of the single wheel impulse type. The wheel or rotor is mounted directly on the end of the generator shaft. Although only one impulse wheel is used an unusually high efficiency is obtained by using the steam 2 or more times on the one wheel. The governor is of the fly-ball type. The weights are hung on hardened steel knife edges, minimizing friction. In case of overspeeding, the automatic safety-stop, throttle valve is tripped, shutting off the steam supply.

Type T generators are of the commutating type which insures sparkless commutation with a fixed

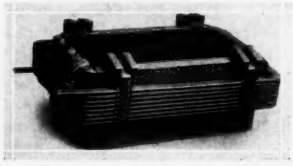


FIG. 2. SHUNT AND SERIES WINDING OF MAIN FIELD

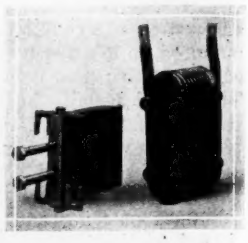


FIG. 3. COMMUTATING POLE AND WINDING

brush position at all loads within the capacities of the machines.

All frames are of cast-iron and divided horizontally with the pole pieces bolted to them. Main poles are built up of soft sheet steel punchings. The use of bolted-on poles permits of uniform pole spacing and in addition renders possible the removal of any individual pole. Commutating poles, Fig. 3, are of steel and are secured to the frames with bolts. Main field coils may be either shunt or compound wound, shunt coils are wire wound on forms and provide a large

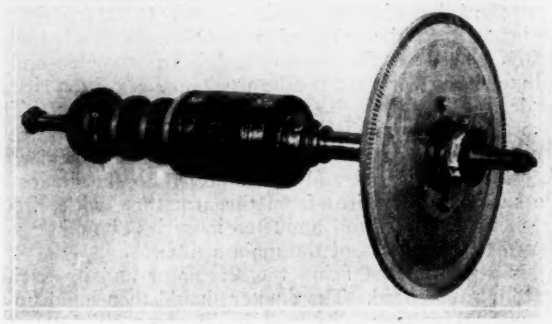


FIG. 4. COMPLETE ROTOR FOR 100-KW. UNIT STEAM AND ELETRIC END

radiating surface, while series coils are wound of bare copper bar. The best possible heat radiation is assured. The commutating pole coils are wound of bare copper bar held in position with insulated bolts, keeping the bar so spaced as to give thorough ventilation. Brushholders are mounted on rigid arms and the brush tension can readily be adjusted to keep it uniform as the brush wears away. Armatures are of the drum type, with coils form wound, interchangeable, and held firmly in place with binding wire to withstand centrifugal stresses, while the spaces between the coils at the ends of the armature are packed with insulating material to prevent the entrance of dirt. Commutators, as shown in Fig. 4, consist of hard drawn copper bars insulated with mica, firmly held by steel rings shrunk around the bars, but insulated therefrom, to prevent distortion by centrifugal stresses.

A complete oiling system of the type best adapted to the service is provided with each turbine. In the smaller sizes this is the ring oiling scheme while in the

larger turbines the oil is circulated through a closed system, by means of a rotary pump driven by the main shaft through positive gearing.

All parts of the turbine are readily accessible for inspection or repair. The upper half of the cylinder or casing may be removed (Fig. 1) without interfering with the valve or governor mechanism, and, if necessary, the wheel or rotor may be entirely removed from the casing.

Generally speaking, the steam consumption of turbines of small powers compares favorably with the performance of automatic high-speed engine of similar capacity.

NEW TYPE OF TRANSFORMER TOWERS

WE herewith illustrate a very suitable type of small-sized transformer stations which show a number of advantages over masonry stations. Apart from a considerable reduction in first cost and the possibility of readily shifting the stations whenever required, they are in fact fitted up completely at the factory, and after being installed on their foundation, are put into working order merely by connecting up the primary and secondary conductors as well as the transformer.

The transformer tower under consideration is generally made of frame work, comprising at the base, a cabin for receiving the transformer and apparatus; being designed as lattice poles, it is of a pleasant ap-

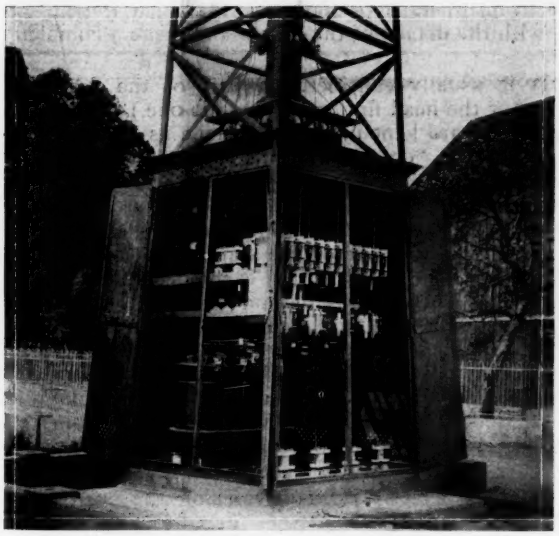


FIG. 1. LOW TENSION SIDE OF TRANFORMER TOWER

pearance and affords a point of support both safe and simple for use in connecting up any kind of conductor.

The cabin is so designed as to afford ample space for a straightforward arrangement of all the apparatus and conductors. It is generally fitted with 2 operating doors, for the purpose of controlling the high and low tension ends respectively, but can be as well made accessible from all 4 sides. The most up-to-date apparatus have been provided for the protection and superintendence of the transformer.

A galvanized sheet-iron tube 11.81 to 23.62 in. in diameter is used for introducing the primary conductors into the cabin. At each of its ends a cast-iron spider is fitted in its interior and it carries the tightening device for 3 or 6 bare copper wires. The sheet-iron tube below the upper roof of the tower rises to a height sufficient to prevent any rain from penetrating into its interior and accordingly into the cabin. The secondary conductors are taken out of the cabin by porcelain pipes protected against rain by a special roof, which at the outside of the sheet-iron tube are likewise arranged in the form of bare conductors. The admission of fresh air is effected through apertures in the foundation, a lively ventilation of transformer being insured by the violent draught in the admission tube. These apertures are arranged in the top part of the foundation, immediately below the iron foot of the tower. Another arrangement, which, though somewhat more expensive, is considerably better, excluding as it does the entering of splash into the in-

FIG. 2. HIGH TENSION SIDE OF TRANFORMER TOWER

terior of the cabin, comprises an aperture closed with a perforated plate on one side of the foundation and through which a supply of fresh air below the transformer is allowed to penetrate directly into the cabin.

Any water oozing out in cold weather inside the sheet-iron tube is allowed to escape through an aperture in its lower end. The transformer towers herewith described are designed in 3 sizes, the space available for the transformer having the following dimensions:

Size A; length 3.28 ft.; height 4.92 ft.; width 2.30 ft.
Size B; length 3.94 ft.; height 4.92 ft.; width 2.95 ft.
Size C; length 4.26 ft.; height 4.92 ft.; width 3.28 ft.

The largest size suffices for the installation of a transformer of fairly large dimensions. If it be preferred to put up small-size transformer towers, the secondary bus-bar is provided with switches for use in allowing the transformers to work separately or in parallel.

FATHER MACDOUGAL ON PROGRESS

The Need of Taking Each Step Before You Take the Next

MY DEAR SON:

It was indeed pleasing to read your very welcome letter of a few days ago and I would have answered sooner but for a slight touch of rheumatism in my right shoulder which has bothered me more or less ever since a well meaning, but misguided Southern gentleman during our late misunderstanding, passed me his compliments at short range at the battle of Winchester. Doctors in those days were not expert at fishing around a man's innermost being for bullets, and that 0.56 caliber Enfield slug has kept my right shoulder in a state of rebellion since the war closed. But I feel a great deal better since Mother put a poultice on it and now I can write with at least a little comfort and satisfaction.

But it is very gratifying first of all to know that you are appreciating the fact that you chose the right road that leads to Success, via. The Scoopshovel Limited, instead of The Ledger & Daybook Accommodation, and it is more gratifying, if anything, to note that your heart is in your work.

Now let me say right here in passing, son, that no man is a success unless his whole heart is in his work. Just the minute that a man begins to look at the clock every 10 minutes, and keeps his ear cocked for the 6 o'clock whistle, for fear his watch may be wrong, just so soon does he begin to slow down, stop, and slip backwards and some one else steps into his shoes.

Then again, Donald; make a note of this: If you have got any get-up-and-dust in you and any grit and determination, you will some day be chief of a plant yourself and when you do, I'll wager that 7 out of 10 of those fellows who are now loafing around the office 7 hours a day (and working one), and go laughing down the street as you say, will still be at the same old job, and borrowing $5 from some loan shark, "till pay day," and will proceed to buy for an equally rattle-brained maid with drugstore hair, and who can't boil coffee without burning it, a $2 bunch of violets, and take her to the opera house to see some $5000 (?) a week actress go into hysterics because she has lost "me che-i-ld."

So you stick to your guns and let the office boys go laughing down the street if they wish. Now-a-days, to win, means a great deal of self denial and self-sacrifice. That does not necessarily mean that one should be a tight-wad, or a miser, but—well, life is too short to find every thing out by your own experience. You must profit by that of others and it is just as necessary to avoid some things, and not learn some things as it is to absorb other things and learn all that is possible about them.

But when you spend your money, let it be done in such a manner that you will get the worth of your money and never regret your act. They say that money talks, which is true but there are many times when it says more by keeping still and saying nothing. One of these times is when it is drawing 6 per cent interest on a mortgage that the assistant book-keeper plasters on his home on the Boulevard so he can buy an automobile—and have plenty of money to keep it in repair and going.

But to get back to the main line again. I should judge by the general tone of your last letter, that Fred, your fireman, is a bright and shining example of misplaced confidence, so far as the Chief is concerned. That but goes to show that some men are absolutely unreliable in a position of trust and responsibility. There are comparatively few men that can "get on the job," without having some one around to see that they do the job right.

While it is not possible for the Chief to see all that is going on, and lay out every little detail and see that it is done, and done right, yet he is the man that is held responsible for the actions of his subordinates and you want to keep it in mind that when the Chief finds out that a man cannot be depended on to keep up his own end and carry out the instructions of his superior (he is bound to find it out sooner or later, as in the case of Fred and his boiler washing stunt, and other things), and when he does find it out, the man might as well look for another job, for there is nothing so hard to recover as lost confidence.

On the other hand when the boss begins to learn that there is something to a man besides a suit of working clothes, and that he is a man that can be depended on to do as he is told and always look out for the interests of the firm, the boss will soon learn to lean on him to look after some of the details and will pay accordingly.

A chief engineer cannot possibly see to all the details of his plant. He must leave a certain amount of it to his subordinates and it is simply a case of selecting the right subordinate. These subordinates must be of such a caliber that they will readily absorb the spirit of the Chief and learn to be a part of the machine and to do their share of the work so that it will "fit in" with the details of the others and make a complete job.

It is usually considered a part of the fireman's duty, (or the head fireman if there is one,) to see that the boilers are kept in as good shape as possible and that they are "on the line" in such numbers as are required for the load, cutting out as the load falls off so that the boilers that remain on the line are operating under the most favorable conditions.

He should also keep some simple kind of a record which shows the length of time each boiler is in service during the week, or month, and see to it that for any given length of time, say a month or a year, each of the boilers will have been in service the same length of time. Now the Chief cannot see to all this, and you can see for yourself that because Fred was not the right kind of a man, there will be a change in the position of fireman and if I am not mistaken, the next fireman will be named MacDougal.

You did exactly right in refusing the position of assistant engineer when it was offered to you. You will remember that I wrote you a year or so ago that there was no short cut to the top of the engineer's ladder, and that it was 1000 miles high. I might add at this time, that there are no passing tracks on it either. Had you taken the position you might have gotten along pretty fair for awhile but there would come a time sooner or later (and sooner than you would think for) when you would want the knowledge that you did not have and which can be learned only on the business end of a No. 5 scoop.

This does not apply exclusively to engineers. It is common to all trades and professions. I don't know whether you remember Eddie Fandeister who went to school out at Sussex—I guess that you were quite small when he left school. Well, he had a perfect

horror of mathematics, and especially of fractions and decimals.

The arithmetic class recited the first thing after 1 o'clock in the afternoon, and as he lived about a quarter of a mile from school and went home to dinner, he found it very convenient to be late at noon and his tardiness was in direct proportion to the snags that he encountered in the lesson. He thought at the time that this was all right and that it would do no harm —and incidentally save him considerable worry.

But there came a time, as there always does, when he found that a difficult matter was made doubly so by the lack of something which he had neglected to learn. The teacher devoted many an evening after school to try and help him catch up, and so much time was spent with him in the class that the other scholars were deprived of the attention and instruction that was rightfully due them.

Finally he became discouraged. He realized, when it was too late, that he had made a mistake and had missed something in his walk along life's pathway that no amount of labor would bring back to him. He left school and tried his hand at a number of things and in each one he tried, he found that to "get away with it," he should know more about mathematics.

He tried the farm, because they say that anyone can be a farmer (but don't you believe it), but he soon found that he could not keep track of the milk he took to the creamery, or the produce that he took to market so he went to the city and got a position—no, a job—in the shipping department of a large factory on the stearing gear of a truck and in the due course of time was promoted to stock keeper but here he fell down because he was shy on his arithmetic.

Then he drifted from one thing to another till he faced the cold fact that he was a failure and doomed to pass through this world of ours as a follower, not as a leader. Several months ago, about the time you went to your present position—no, job—I saw in the Southport Herald that he was killed by the fall of a coal bucket into the hold of the barge, Shandon Belle. The paper stated that he had been a stevedore for about a dozen years.

Now, my boy, this all goes to show that it doesn't pay to skip any of the fine points of the game on the way up if you want to be a winner at the top. I remember well, years ago, more than I care to think about, when the school master used to "set" us a copy, that he set this one for me in my old blank copybook: "Whatever is worth doing, is worth doing well," and of all the things that I learned when I was young this motto stands out above them all.

So you see that when the fireman sprayed the interior of those old tubular boilers with a hose as if they had been a case full of cigars, that he was not familiar with the motto mentioned above. Washing a boiler is just as much of a task, and requires just as much attention to do it right, as it is to set the valves on a cross-compound Corliss air compressor.

Keep this fact in mind, Donald: Coal is burned under a boiler for the sole purpose of generating steam to operate steam driven machinery and not for the purpose of disposing of it as if it were garbage or refuse. And in order to use just as little as possible, it is necessary that the boiler be in the best condition possible to absorb the heat units liberated by the fuel.

The 2 principal conditions are that the boiler heating surface be free from all insulating material, inside and out, which gives the heat units a chance to pass from the coal to the water with the least amount of resistance, and it cannot do this when there is any scale or sediment on the shell or tubes or an accumulation of soot on the other side of the metal.

When one stops to consider that at the most, the percentage of energy stored in the coal which eventually is utilized for the operation of the machinery is about 10 per cent, it behooves us to get right up and hustle to keep this percentage from getting any lower.

There are a lot of other things necessary also that the fuel consumption be as low as possible, such as draft, design of the grate-bars, leaks in the boiler setting, and short circuits. Short circuits can occur in the generation of steam the same as they can in the generation of electricity.

Why, the other week, when I was out for my usual daily stroll, I walked down the track to a little woodworking establishment and the first thing that struck me as I stepped into the boiler room, was that the breeching and all of the stack that was visible below the roof, was a rusty red and showed the effects of more heat than ought to be in such a place.

The combination engineer-fireman-electrician leaned on his scoop and was very talkative. When he opened the door to fire up, I noticed that the flame was not hurting itself in trying to get over the bridge-wall and when I remarked casually that as the day was so muggy that it affected the draft, he "allowed" that the day had a whole lot to do with it but that the boiler was too small.

To prove his assertion, he did the very thing I wanted him to do; he opened the breeching door and there I saw that the brickwork had fallen away and permitted the flames to pass directly from the grates to the stack through a hole that you could throw a dog through—and getting bigger every day. The e.-f.&-e. thought that the hole was not to blame because the boiler steamed so hard and said that he thought that it didn't hurt it any for, as he said, "the hole had always been there so far as he knew." So look out for the leaks around the boiler and you will not burn so much coal, and will get more out of what you do burn. Mother sends her love to you.

Affectionately, your father,
Sandy MacDougal.

BUILDING CONSTRUCTION in winter, particularly where there are large amounts of masonry, is usually a difficult proposition because of the high cost of safe construction in cold weather. The method of winter construction for reinforced concrete work used by the Aberthaw Construction Co. has been in successful use a number of years and consists in heating sand, stone, and water before putting them into the mixer. The cement is not heated, as its setting is hastened too much by such process. Sometimes salt is mixed with the concrete in the proportion of 2 lb. of salt to each bag of cement.

In placing the concrete all snow is, of course, removed from the forms by a steam jet and the building, as it goes up, is enclosed floor by floor with canvas until the concrete is set. Salamanders are kept burning underneath all freshly poured concrete floors until the concrete is thoroughly set, and in this way the interior of the building is kept some 30 deg. above that of the outside air. Where the tops of concrete floors cannot be enclosed with canvas, they are covered with about 12 in. of hay or straw, sometimes sprinkled with salt. In this way the Aberthaw Co. claims to get as good work as if the building were erected in summer, but, of course, the construction cost is somewhat higher than summer construction, because of the extra precautions. This increased cost amounts to from 6 to 10 per cent.

EFFICIENCY WITH CHAIN GRATE STOKERS

Practical Methods of Handling Fire on Chain Grate, Principles Involved, Depth of Fuel, Regulation of Draft

By Dan L. Royer

MANY chain grate firemen who are good, willing men, burn tons of coal uselessly and do much unnecessary work because no one goes into the principles of combustion with them, far enough for them to get a clear idea which is the right way to fire, and why this particular way is the right way. Perhaps the chief comes into the fire room and tells the fireman that he has too much draft for the proper combustion of his coal, but unless the chief explains "why," the fireman is very likely to think his way of firing is as good as the chief's.

Regulation of Combustion

THE whole proposition in firing to get good combustion, with any stoker or grate, is the proper regulation of the depth of the fire in relation to the intensity of the draft. A few words on the theory of combustion will show how essential the proper adjustment of the draft is. To burn 1 lb. of carbon to CO_2 requires 11.6 lb. of air at 62 deg. F. Allowing for the sulphur in the coal which requires some air to burn it, we have to allow, approximately, 12 lb. or 160 cu. ft. for the proper combustion of 1 lb. of coal. If the draft is so intense that more than this amount of air is admitted to the furnace, per pound of coal burned, there will be a great loss in heating the excess air to no purpose.

For the complete combustion of carbon with no excess air the analysis of the gas given off should be 20.91 per cent of CO_2 and 79.09 per cent of nitrogen. In practice if you can get from 12 to 15 per cent of CO_2 in the flue gas, with the dampers wide open, you may be sure you are getting all you can out of the boilers because with this per cent of CO_2 there can not be much excess air admitted to the fire, and the fact that the dampers are wide open shows that the grate is burning all the coal that can possibly be burned with the draft available. The presence of CO_2 in the flue gases is an absolute check on the quality of the combustion and when the per cent of CO_2 falls you may be sure something is wrong.

Speed of Chain Grate

WITH the chain grate stoker it is generally desirable to run the grate at a speed of about 3 in. per minute. If the fire is run just thick enough so that it will be burned out when it reaches the water back, with this grate speed and with the damper wide open you should get 11.5 or 12 per cent of CO_2 and of course you would be pulling the boiler to the utmost capacity, under the conditions present.

If, however, the grate must be run faster than 3 in. per minute to keep the fire up to the water back, the fire is being run too thin and the per cent of CO_2 will drop because the air can get through the thin fire bed without all the oxygen in it combining with the carbon in the coal, and the only thing to be done is to increase the depth of the fire or reduce the amount of draft.

A good way to correct a low per cent of CO_2 is partly to close the damper, if possible for 10 or 12 minutes, if the per cent of CO_2 increases you will be safe in increasing the depth of the fire and running with the damper wide open. No rule can be set down for the thickness of the fire in relation to the different degrees of draft, because fine coal and slack must be burned in a thinner fire, with a faster grate speed and more draft than the coarse sizes of coal, but with a draft of 0.5 in. water you will be safe in running a fire from 8 to 10 in. deep, with a grate speed of about 3 in. per minute. With only 0.25 in. of draft the fire should be about 6 in. deep with the same grate speed.

It can readily be seen that the fireman who gets 10 or 11 per cent of CO_2, with the damper wide open, and a draft of 0.5 to 0.55 in. is getting a great deal more out of his boiler than the fireman who gets from 12 to 15 per cent of CO_2 with his damper partly closed and a draft of 0.25 to 0.3 in. It is desirable to get just as great a percentage of CO_2 as possible, but it is essential to run just as few boilers as possible and handle the load safely.

Regulating the Draft

WITH a battery of boilers pulling on a steady load the fireman should have no trouble in setting his grate so that he gets a good per cent of CO_2 and does not run unburned coal over into the ash pit, but with a load that varies 500 kw., or more, in 15 minutes, it takes skillful handling to keep the steam pressure constant and get a good per cent of CO_2.

A good way to fire with a varying load is to set the dampers and adjust the speed of the grates so that no unburned coal is going into the ash pits and the per cent of CO_2 is good. When the steam pressure rises, close the damper and decrease the grate speed on the boiler, whose safety valve blows off first, and leave the other boilers undisturbed. When the pressure begins to fall a little the damper can be opened and the grate speed increased. The other dampers may have to be closed a little, but if you can take care of the changes in load with 1 or 2 boilers, the chances are you will have very little trouble with the rest of the boilers in the battery, that are steaming steadily.

The dampers should never be entirely closed, because this procedure deadens the fires so that several minutes are required before they will pick up again, when the dampers are opened. This closing the dampers tightly is one of the most fruitful causes of sudden drops in the steam pressure, but if they are always left cracked open the fires will respond at once when the dampers are opened wide.

It should be seen that the ash pit doors close tightly because any air admitted here will be sure to cause a drop in the per cent of CO_2, no matter how good the fire is, and if the opening is large enough it will cause the grate to heat, because the air will be drawn through the ash pit instead of through the fire.

With deep fires there will be some trouble with clinker forming on the side walls, but this difficulty can be overcome by the proper use of the slice bar. The bar should be of good heavy stock, long enough to reach the water back and should have a blade 4 or 5 in. wide. The blade can be pushed under the clinkers, which are dislodged by turning the bar so that the blade comes in a vertical position.

If the bar is used on the fires every 4 hr. there should be no trouble in keeping them clean, but if the clinker is allowed to get large the fire will be ruined when it is cleaned, and the fireman will have lots of unnecessary work of the hardest kind. The easiest way to fire is the best way, and it is easier to keep the fires clean than to allow the clinker to collect and have a hard time removing it and keeping the steam pressure up at the same time.

THE ELECTRIC PLANT AT VITRY SUR SEINE*

Where Mechanical Firing and Conveying Does Away With Drudgery

By Engineer Nerger

ONLY recently have mechanical labor saving contrivances been introduced in Europe for the handling of boilers. Among these mechanical firing, as accomplished by chain grates, not only leads to an economy of labor but, which is of still greater importance, makes possible the employment of larger boiler units than have ever before been used. Formerly the range of boiler sizes was limited, since even the best fireman cannot properly and economically stoke a grate which is more than 8 ft. long. In order, therefore, to obtain a large heating surface, boilers had to be built extremely broad, which led to serious difficulties, as it is only under rarely favorable circumstances that room is available for such broad boilers

Since the introduction of automatic firing, boilers of much greater size have been constructed. The heating surface of a boiler formerly rarely exceeded 4000 to 4500 sq. ft., which normally delivered 3 lb. of steam per hour per square foot of heating surface. Now it is quite common to erect boilers having 5500 to 6500 sq. ft. of heating surface and an output of 4 to 6 lb. per sq. ft.

Mechanical firing is also instrumental in diminishing smoke to a very considerable extent, and this is accomplished in spite of the fact that all mechanical firing is effected with a comparatively small excess of air. All other conditions of complete combustion are carefully provided, for instance, the carbonization of the fuel takes place in the first zone of the chain grates and the gases of combustion are forced to pass over the whole of the glowing fuel bed. Since the whole of the firing is accomplished with closed doors, and very often even the cleaning of the grate is automatic, the losses occasioned by the inflow of cold air, which is considerable during cleaning by the ordinary method, are avoided and the efficiency of the boiler is correspondingly increased.

The coal handling plant has also been greatly affected by the development of mechanical firing, for, if laborers have to fetch the coal and shovel it into the hoppers of the firing apparatus, the greater part of the work remains. The transportation of the coal must also be made automatic in order to effect a real saving.

*Abstracted from the Zeit. des Bayerischen Rev. Ver.

The electric plant at Vitry sur Seine of the "Compagnie Generale de Distribution d'Energie electrique" in Paris illustrates how perfectly mechanical aids may be employed in large boiler plants. These works were built according to the plans of General Director Garfield of the French Thomson-Houston Co., and the most recent American electric plants served as models for the fitting out of this plant, in which almost all manual labor is done away with.

The Vitry works are designed for the production of high-tension polyphase current at 13,800 volts, having a frequency of 25 periods. The current is principally used for traction purposes, that is, for the running of street cars, not only in and about Paris but also for electric trains going considerable distances. A part of the energy, in the form of a high-tension polyphase current, is conducted to the busbars of the plant, but by far the greater portion is transmitted by means of subterranean conduits to the substations in Paris and its suburbs, where it is then transformed into direct current at 600 volts.

At the present time the power station possesses 4 9000-kw. turbine generators, but in time it is hoped that sufficient enlargements will be made so that the total output will be 70,000 kw. In the following description of the works, special emphasis is placed upon the boiler plant. The data, as well as the drawings of the plant as reproduced in the cuts, were supplied by the builders of the works, the Thomson-Houston Co. of Paris.

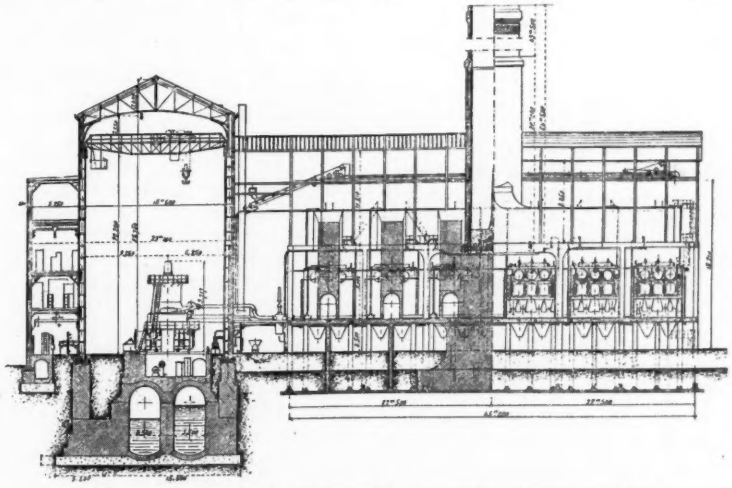


FIG. I. SECTIONAL ELEVATION OF VITRY POWER PLANT

The Coal Conveyors

ALTHOUGH the fuel used is English coal and is brought by water, provision has been made to bring fuel in sufficient quantities by land, in case of need. The unloading of the coal from the Seine boats, its distribution upon the broad landing stages, which are directly on the shore of the stream, and the conveying of the coal to the boilers, are all entirely automatic.

An electrically-driven revolving crane, carried upon tracks and furnished with an automatic bucket, unloads the boats and conveys the coal either to the landing stage or immediately to an endless belt leading into the boiler

plant. When there is no ship to unload, the revolving crane busies itself with taking coal from the landing stage and places it upon the conveying belt.

The transporting belt, which is electrically driven, leads diagonally upward and takes the coal from the quay to the top of the boiler house, which means a height of about 58 ft. At the highest point the coal is distributed by means of a special apparatus, composed of various vertical transporting belts which are provided with shiftable dumping arrangements, and are placed over the large bunkers in front of the boiler batteries. One of these bunkers is provided for every 6 boilers and holds about 15,000 tons of hard coal. With the aid of the shiftable dumpers any of the bunkers may be easily filled with coal. The bunkers are at a sufficiently great height to allow the fuel to flow by gravity through sloping tubes to the hoppers of the mechanical stokers. At the bunker discharge, iron slides are placed, by means of which the inflow of coal to the separate funnels may be regulated. The slanting tubes through which the coal falls are so arranged that they may be swung around, by which means one tube is sufficient to feed the 4 hoppers of a stoker.

The large bunkers, as well as the whole of the boiler housing, is constructed of reinforced concrete, and as there are no struts or supports in evidence, the whole structure with its colossal weight seems to hang free in the air.

The transporting plant is capable of handling 100 tons of coal in one hour from the ship or from the landing to the bunkers.

The Boiler Plant

THE original boiler plant comprised 2 groups of 6 boilers. An extension is now building which is to comprise 2 more groups of 7 boilers. The 2 groups are erected parallel to one another. This arrangement makes all parts open, easy to inspect and accessible. The house, which is about 65 ft. in height, embraces several stories.

In the basement narrow gage tracks are laid for the small dump cars which serve to convey the ashes and clinker which are collected in hoppers built of reinforced concrete and placed under the boilers; the contents of the hoppers may be dropped into the dump cars by opening the slides provided, and are then transported to a pit and dumped. From there they go by means of a distributing apparatus upon an upward slanting belt which at its highest point unloads onto a horizontal belt, which in its turn leads from the boiler plant across the street to a large dump. Here the ashes may be unloaded upon wagons brought under the belt, and carried out for spreading over roads, etc., or they may be carried to boats.

The first floor of the boiler house is designed for the attendants. The mechanical firing takes place there, and the coal hoppers which receive their coal from the high bunkers through the gravity tubes, are situated there, and the gates at the bottoms of the bunkers are easily manipulated by the firemen by means of chains. Thus mechanical firing attends automatically to the moving of the surface of the grate, the distribution of the fuel upon the grate, and the removal of the incombustible residue. The latter is collected in the hoppers mentioned and emptied every 5 or 6 hr., as necessary Among the movable bars of the grate is a water piping system provided with sprinklers, first, for the purpose of keeping the bars of the grate cool; and second, to loosen the clinker. Since the mechanical firing reduces the duties of the fireman to a minimum, one man can attend to 3 boilers.

The second story of the boiler plant is at the height of the economizers and the third at the height of the belt conveyors above the coal bunkers. In the center of the 2 groups of boilers which were first constructed is placed the common chimney, also entirely of reinforced concrete. The chimney stands 212 ft. above the boilers, the total height from the grate is about 230 ft. It's clear opening, which is the same size at top and bottom, is about 8 ft. 3 in.

Every 3 boilers have a common flue, the 4 flues of the first 2 groups unite at the foot of the chimney, so that the gases from the flues placed opposite to one another should not impede each other, a baffle about 16 ft. high is placed in the lower part of the chimney.

The steam boilers are small-tube water-tube boilers, designed after the Babcock & Wilcox system and built for 200 lb. working pressure. The heating surface of each boiler is 5380 sq. ft., the heating surface of the superheaters is 1345 sq. ft. and of the economizers 1720 sq. ft.

To gain all possible room for the steam in the boilers, each boiler is provided with 3 upper drums. Special stress should be laid upon the arrangement that admits of having the boiler, the superheater and the economizer all in one common housing. The superheater lies, as is customary, between the bank of tubes and the upper drums. The economizer, however, is not situated, as is customary, behind the boiler, but is placed above it. We thus get upon the comparatively small ground area of 484 sq. ft. a total heating area of $5380 + 1345 + 1720 = 8445$ sq. ft.

The draft in the boilers is so arranged that the gases of combustion rise vertically over the grate and directly above the bank of tubes strike the superheater. The gases then pass down and up again, then leave the boiler at the highest point of its housing, whence they immediately rise to the economizer, flow through it and then enter a flue at that level. The superheaters are also built according to the Babcock & Wilcox design and were supplied by the boiler firm. The economizers are built according to the Green System by E. Green & Sons.

The mechanical firing apparatus was produced from the Economy Firing Co., of Dusseldorf. The utilizable grate surface per boiler is 116 sq. ft.. The stoking apparatus is built as a fourfold affair and is driven by an electric motor, whose current is transmitted under the floor. The speed with which the grate moves may easily be regulated by means of a controller, and the amount of fuel to be used is varied, within considerable limits, by adjusting a slide provided with a lever.

The boilers are furnished with all the modern appliances, such as water meters, flues, thermometers, draft gages, etc. For the feeding of the boilers, a centrifugal pump directly connected to a De Laval steam turbine is of especial interest.

When the first 2 groups of boilers were installed, the builders, the Thompson-Houston Co., and the contractors, or the Company of La Courneuve and the Economy Firing Co., Dusseldorf, joined in making extensive evaporation tests.

The guarantees given by the contractors were as follows:

1. Normal Operation: Each boiler must be capable of delivering continuously 17,600 lb. of steam under a maximum pressure of 206 lb. and a temperature of about 540 deg. F. The efficiency of the total plant, that is of the boiler, economizer and heater, not to be less than 78 per cent of the heat value of the coal. The heat value

of the coal is assumed at 13,500 B.t.u. and its ash content at 10 per cent. The specific heat of the superheated steam is taken as 50 deg. above that due to the pressure.

2. Overload: Conditions being otherwise the same, the boiler must generate per hour, during a test of at least 4 hr. duration, 22,050 lb. of steam at 200 lb. pressure and superheated to 558 deg. F. At the same time the efficiency must be at least 76 per cent of the heat value of the coal.

The contractors for the stokers also guarantee the automatic cleaning of the grate and an absolute technical freedom from smoke.

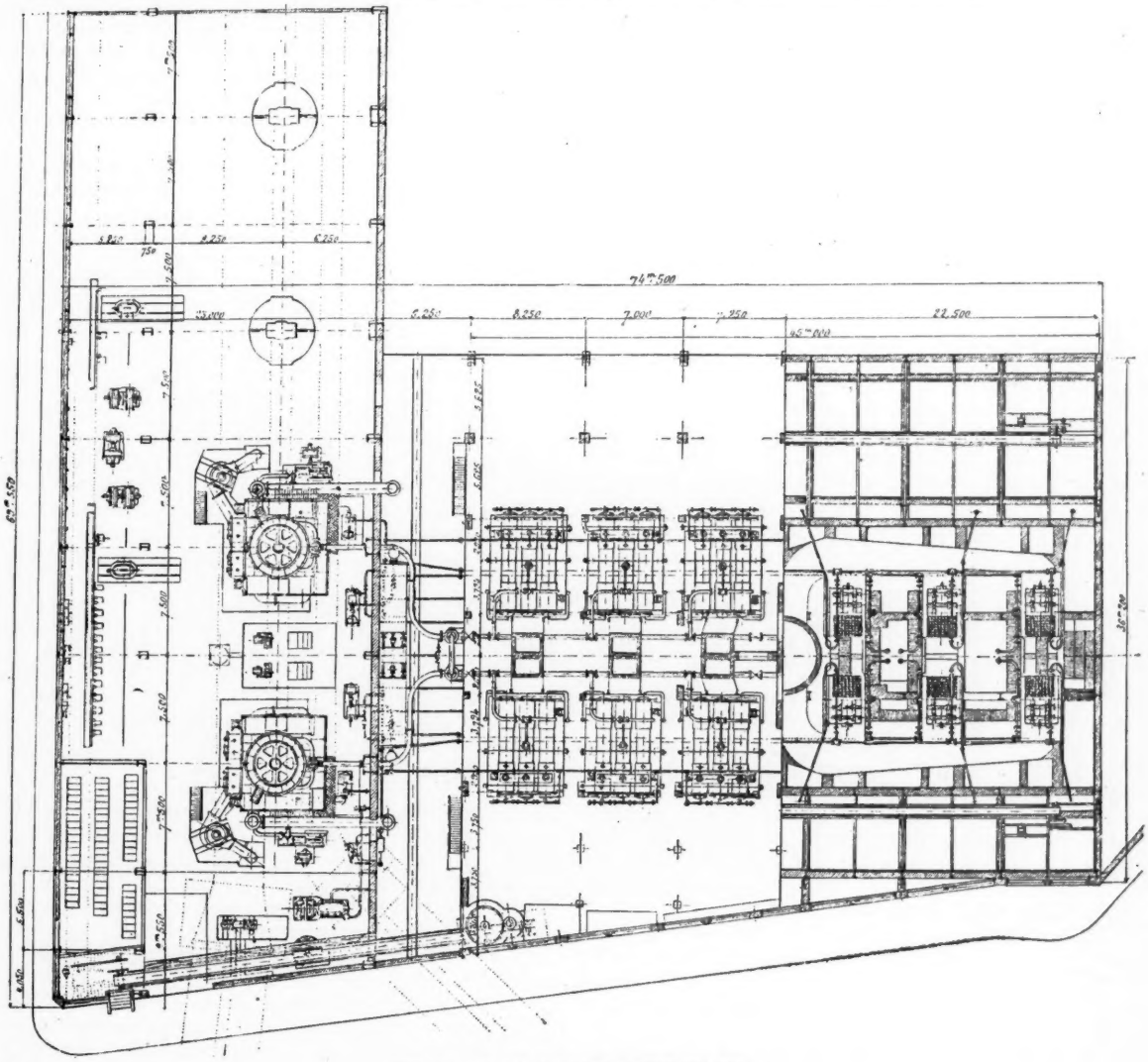


FIG. 2. PLAN OF THE VITRY PLANT

The management of the works selected 3 boilers for the tests. The boilers were carefully cleaned, and a run conducted by several engineers together; and then if there was any need for it the boilers were put in order. Special attention was paid to having the masonry tight.

Water was measured because of the difficulty of weighing the large amounts used, the meter showing a calibration error of only 0.73 of 1 per cent. Coal was sampled and tested as usual for heating value and moisture, and readings taken every 15 min. of pressures and temperatures of steam, water and air. Flue gases were analyzed by Orsat apparatus and the Bunte burette. Tests were made at approximately 17,600 and 22,050 lb. of steam evaporated per hour.

The principal results of the tests at lowest and highest capacity were as follows:

Coal used was an English fine Cardiff, burned on a grate surface of 116 sq. ft. The moisture in the coal tested was 5.56 per cent, ash content 9.03 per cent, giving a heating value of 13,150 B.t.u. In the minimum test, the coal per hour per square foot of grate surface was 17.2 lb., and in the maximum 21.2 lb.

Feed water for the minimum capacity was 120.2 deg. F., in the hot wells, and for the maximum test 118.4. Entering the economizer the water temperature was 107.6 for the minimum test and 105.8 deg. for the maximum. In the economizer the temperatures secured were 203 and 192.2 respectively. At the minimum rate the water per square foot of boiler surface per hour was 3.28 lb., and the maximum 4.17 lb. The boiler pressure for the minimum capacity was 188.7 and the maximum 193 lb. per square inch and the temperature of the saturated steam 385 and 386 deg. F. When leaving the superheater the temperatures were 579 and 601 deg. respectively. This gives a superheat of 194 deg. for the minimum test and 215 deg. for the maximum.

For the gases leaving the boiler, the temperature was 469.4 deg. F., minimum capacity test, and 491 deg. for the maximum; when leaving the economizer the temperatures were 266 and 268.7 deg. respectively. Draft at the end of the boiler for the minimum capacity test was 0.74 in. water and for the maximum capacity 0.89 in. Gas analysis for the 2 tests showed for the minimum capacity, carbon dioxide 10.5 per cent, carbon monoxide 0; oxygen 9.7 per cent: For the maximum capacity test, carbon dioxide 10.7; carbon monoxide 0; oxygen 9.2 per cent. The evaporation of water per pound of coal under actual conditions were 8.83 lb. for the low test, and 9.12 lb. for the high test, giving an equivalent evaporation from and at 212 deg. of 11.23 and 11.75 lb. respectively.

Amounts of heat absorbed were for the low test, by the boiler, 68.98 per cent; by the superheater 6.48 per cent, and by the economizer 6.37 per cent or a total 81.83 per cent. For the high tests the amounts were by the boiler 71.65 per cent, by the superheater 7.36 per cent, by the economizer 5.95 per cent, or a total of 84.96 per cent. Heat lost in the chimney gases for each test was about 7 per cent; and by radiation through grates and so forth about 1.12 per cent for the low test and 8.04 per cent for the high test.

These results show that all the promises of the contractors were realized. Compared to other plants, the loss through the chimney is small, and the proper construction of the masonry makes the loss through radiation also very slight. The guarantee of freedom from smoke is also practically to be relied on, for it is only on very rare occasions that a faint cloud of smoke is seen to arise from the chimney.

The results gained with the large boiler units in the electric works were so good that for the extension considerably larger ones have been chosen. Each one is to have not less than 7100 sq. ft. of heating surface and about 193 sq. ft, of grate surface. The contract for these has also been given to the "Fonderies et Ateliers de la Courneuve."

3. The Turbine Plant: The steam turbines with their direct connected generators were brought from America. They are built after the Curtis system, and have vertical shafts, the arrangement of each turbine being such that a double condenser is built in the base and supports the whole turbine as well as the polyphase current generator. On the floor above the condensers is the turbine housing with its many staged gallery, the top of the whole being formed by the generator and the total height of the whole being about 32 ft.

The condensation is effected in the usual way by means of a surface condenser, the cold water being drawn from the Seine. For the condensate a centrifugal pump is provided, while a vertical piston pump is used for the air.

The turbines run at 750 r.p.m. and have the lubrication of the step bearings accomplished by means of oil pumps of special build. To every group of 2 turbines there is a group of 2 pumps, each of which alone would suffice to supply the oil needed by the 2 turbines.

The switchboard, which extends over 3 stories, is furnished with every conceivable modern appliance and comprises a whole series of the most complete instruments, as, for instance, recording volt and ammeters, wattmeters, etc. The power for operation of switches for the whole works is accomplished by a special 300-kw. turbo-generator.

The auxiliary machines in the works, as for instance, cranes, elevators, oil pumps, etc., are all driven electrically, by a primary current of 13,200 volts, changed by 3 transformers into a polyphase current of 550 volts.

TESTING FEED WATER

By James F. Miller

I ENCLOSE the analysis of 2 samples of water. One taken direct from the artesian well, the other from the system, the water being drawn from the heater.

The hot well had been pumped full one hour before the sample was taken. This well holds 1000 gal. so it ought to be a fair sample of running conditions. It goes to show what can be done with a bad water when you are prepared for it. We run condensing, the cooling water is supplied by the artesian well. The condensed steam is returned to the hot well at a temperature of 120 deg. It then passes through a Hoppes heater to the pumps, then through a Green economizer, then to the boilers, often reaching 260 deg. at the boiler.

Losses of water are made up as follows: The hot condensing water is forced by an ejector to one of the 2 rain water tanks where it syphons into the second. From here it is pumped to the hot well as required. Our 3 Stirling boilers have now been run 2½ yr. and not one cent has been paid out for repairs, except for furnace work. The tubes of each boiler have been bored once, and then for mud. As a rule tubes in this section last but one year.

ANALYSIS OF WATER AT POWER STATION OF ST. JOHNS LIGHT & POWER CO., St. Augustine, Fla.

	Sample No. 1 Artesian Well Grains in 1 Gal.	Sample No. 2 Feed Water Heater
Total solids	197.54	27.34
Scale forming solids	57.25	1.16
Calcium oxide	14.99	.12
Magnesium oxide	11.89	.27
Chlorine (combined as sodium chloride)	115.11	12.24
Sulphuric acid (in combination as sulphate)	22.78	4.69
Iron and aluminium oxides	.13	.52
Silica	1.59	.29
Hardness, temporary	7.22	6.72
Hardness, permanent	26.00	None

POWER-SITE RESERVES embracing 28,147 acres were created during February, in California, Colorado, Idaho, Montana, and Utah, as a result of investigations and recommendations by the United States Geological Survey. These lands are withheld from public entry pending proposed legistation by Congress which shall provide for the manner of their development. Reservoir sites were also created covering 8,542 acres.

During the month restorations to the public domain were made of lands previously withdrawn but found upon examination to contain no valuable power sites, to the amount of 7,000 acres in Idaho, Oregon, and Washington.

IN A RECENT discussion regarding oil engine pistons Mr. Wolcott Remington stated that in such an engine the length of the piston should not be less than 1½ times the bore as this gives ample bearing surface. Mr. Remington advises using light piston heads thoroughly ribbed on the under side because this does away with the excessive pressure from the piston and at the same time gives ample strength. The ribs also radiate the heat from the piston head and so prevent its becoming overheated to the same extent it would if there were no ribs. In the case of a 10 by 10 in. engine of the 2-cycle Blanchard type the length of the piston would be 15 in. with thickness at the top 1½ in. and at the side ⅜ in.

FINDING REFRIGERATING TROUBLE

What Jim, the Chief, Taught Ed, the Day Assistant, and Jerry, the Night Assistant, About Keeping an Absorption Plant Straightened Out

By Walter C. Edge

"HOW is the machine working, Ed?" Jim asked as he entered the engine room one morning.

"Not very good," said I. "The brine was 10 below zero, when I left last night, and it is 4 above now, still losing ground, and I do not know where to look for the trouble."

"Look at your cooler pressure Ed; it is 35 lb. isn't it?"

"Yes, I know it is too high, but the expansion valve is set at the usual place, and the weak liquor valve is set just right too; so I don't understand what makes it so high."

Generator Pressure and Strength of Weak Liquor

"YOU don't look far enough, to find the trouble. Just glance at the steam gage on the generator coil; it shows but 10 lb. and you know I told you and Jerry to keep the pressure up to 45 lb. for good results."

"Well the last machine I operated always worked far better on 10 lb. than any other pressure," I remonstrated.

"True enough! but what is best in one plant, is far from best in another, particularly in absorption plants. The conditions of each plant must be considered separately and the best working points obtained by tests, as no 2 machines will work alike in all points."

"Admitting all this," said I, " how could the high pressure in the cooler come from low steam pressure in the generator coils?"

"Let me ask you a few questions," said Jim, "and I feel sure you will see why for yourself. What is the usual strength of the weak liquor going to the absorber?"

"About 18 percent," I promptly answered, for I had studied this part of the machine about a week ago.

"Good! What strength is the returning strong liquor?"

"About 28 percent," said I.

"Right again! The weak liquor, then absorbs 10 percent gas from the cooler. Now returning to the steam coil. It requires a certain amount of heat to boil out that 10 percent gas doesn't it?"

"Yes," said I, beginning to see the connection between the steam coil and the cooler.

"Well, I have found that in this plant it requires 45 lb. steam pressure to do it, and, therefore, when but 10 lb. is carried, the weak liquor gains in strength, and instead of sending it to the absorber 18 percent in strength, we will say it is 23 percent. What would be the result?"

"Oh!" I exclaimed, "it is clear now. If the weak liquor was 23 percent it could only absorb 5 percent or half as much gas; and with the expansion valve open to the usual point the pressure would be sure to rise in the cooler."

"That's it exactly. Now draw off a little of the liquor from the generator, and we will test it."

I did as I was told, and when it was tested it was found to be 22 percent.

"Now that we have the cause of the trouble, Ed, we must correct it; so cut down on the expansion valve; open the weak liquor valve a little more, and keep the steam pressure up to 45 lb., but watch the generator pressure carefully. Don't allow it to go higher than 200 lb. If it reaches 200, cut down the steam pressure to 40 lb., or even 35 lb.; but remember the higher you carry it, the more quickly you will reduce the strength of the weak liquor."

I found that 40 lb. was as high as I could carry for about 1 hr., at which time the head pressure started to drop, permitting me to raise the steam to 45 lb. It finally dropped to 150 lb., and as the cooler pressure was now 12 lb. I reset the expansion and weak liquor valves. The brine now back to 10 above zero began to drop immediately, and by 5 o'clock that day I was able to report the brine 12 deg. below zero.

Everything went smoothly for several days, until one morning I found the brine back again to 8 deg. above zero. Upon questioning Jerry, I was told he had kept the steam at 455 lb. all night, as he had done every night since the trouble. This seemed strange to me, so I started right in to locate the trouble. Looking at the gage board I noticed the cooler pressure to be 25 lb. and the generator pressure 195 lb. I immediately come to the conclusion that Jerry had not told the truth regarding the steam pressure, as everything seemed to be exactly the same as noted during the previous trouble.

Water Supply to the Rectifier

"WHAT are you doing Ed?"

I looked up and saw Jim watching me. "Testing the strength of the liquors," said I. "The machine is in the same condition it was the other day, with the exception of the steam pressure, which Jerry said he carried at the proper point all night. I did not believe him however, and started to investigate, and I think I have proved my belief to be true, as the strength of this liquor is 20 percent."

"Jerry may be right about the steam pressure," said Jim. "Run up the ladder and see what is the temperature of the water in the rectifying tank."

"Sixty degrees," I said as I returned to the floor, "and I cut down on the water supply, as it should be 120 deg."

"Well Ed, you see the steam had nothing to do with it this time."

"All this trouble was not caused by that little tank was it Jim?"

"Why, certainly; don't you know what the rectifying tank is used for? You just told me it should be kept 120 deg.; now tell me why it should be kept so."

"I confess, Jim, I don't know why; only I know it should be, because I was told so by my last chief."

"You'll never be a success Ed, if you are content to run things as you are told, without understanding why they are run that particular way. There is a right way of doing everything, and a reason for doing it that way, and you should never be content with knowing the way, and not understanding the reason. If there is anything you don't understand, ask questions until you do.

"Now coming back to the rectifying tank: The purpose of this tank is to condense the moisture in the ammonia gas, and return it to the generator. To do this the water must be about 120 deg. If it is too

hot, the moisture will pass right through to the condenser, and finally reach the cooler, where it would stay until removed by purging.

"Now, this morning the water is 60 deg., consequently, it is condensing not only the moisture, but considerable ammonia gas, sending it back to the generator, strengthening the aqua ammonia, and causing the same trouble that occurred several days ago.

"Now go back to the rectifying tank, and shut the water off entirely, until the water now in the tank reaches the proper temperature."

I did as I was told, and after several hours the machine was again doing good work.

Everything ran nicely for several weeks. I was just beginning to feel confident I understood the machine thoroughly when I noticed the same conditions appearing once more.

The generator, absorber and cooler pressures were unusually high. I looked at the thermometer, and found the temperature of the brine back several points. Noting that the steam pressure was right, I came to the conclusion the rectifying tank was cold again, only to find it just right upon investigating.

A Hot Absorber

QUICKLY running to the machine shop, I told Jim of the trouble, as I knew at that time of the day it would not do for the machine to go back too much. He gave a quick glance at the gages, walked over to the absorber, placed his hand on it only to withdraw it quickly.

"Feel the absorber, Ed," he said. I did so, finding it very hot; but stood still, not knowing what to do or say.

"Well, what do you make of it?" inquired Jim.

"I guess there is too much weak liquor going over," said I.

"Take a trip out to the cooling water pump, Ed, and see what it is doing, and I think you will find the trouble."

I realized immediately what had occurred, and on arriving at the pump, found it was working on one side only. Quickly removing the suction cover, I found a small piece of wood under the valve. It took but a few moments to straighten things out and get running again.

THE ENGINEER*

His Position in the Plant and Relations with the Manager

By William Westerfield

THE ambitious engineer is coming into his own. This fact is evidenced most conclusively by the recognition that he is receiving on all sides. Associations such as this convention represents, have contributed not a little to the hastening of this consummation. The various manufacturers associations are indicating by their cordial conduct and attitude that they appreciate the importance of the engineer. For these manfestations of approval of our aims and methods, it behooves the engineer to be duly appreciative. The good manager is the best friend the good engineer can have, and vice-versa—the good engineer can do more for the good manager than any other man on the job, and the manager is rapidly coming to a recognition of this fact.

A few years ago the consulting engineer looked upon the "man on the job" with a certain degree of pity or contempt, depending upon his disposition. This condition is rapidly passing, and the consulting engineer of today, in most cases, recognizes in the operating engineer a most essential ally.

Another thing that has contributed not a little to the development of cordial feeling between the operating engineer and the consulting engineer is the fact that the consulting engineer has come to realize that the work of the operating engineer leads him into experience and knoweledge that does not come to the consulting engineer in a way so practical and useful, and that he can swap experiences with the operating engineer without getting cheated in the deal.

For the recognition that has come to the engineer from the manager two causes are mainly responsible. These are the growing broadness of mind of the managers themselves, and the ability which the engineer, as a rule, has shown to meet the ever increasing responsibilities which changing conditions have thrown upon him.

Much depends upon the good understanding that ought to exist between the engineer and manager. To maintain such relations requires some test and forbearance on the part of each many times.

I remember a good manager—a man who got results through his ability to command the loyal effort of every man on the job when it was necessary to do a little extra work, or to crowd a little more work than usual into given time. He made it a practice never to continue a conversation with a man when he could see that either party to it was losing his grip on his judgment, or more clearly, his temper. He would simply walk away. When we conquer a man by the force of moral example, we make a friend, when otherwise, we make an enemy and degrade ourselves.

I don't like to see an engineer afraid of his manager, any more than I would like to see a manager afraid of his engineer. I like to see an engineer who can go to his manager and tell him what is needed; what is wise with reference to his department. I like also to see the engineer who is wise and generous enough to understand that even if the manager believes in him, and believes in the wisdom of his advice, that he cannot do as he pleases any more than the engineer can. The engineer should be patient. Don't allow yourselves to believe that the manager is indifferent unless you know it. Give him the same confidence you wish him to extend to you.

The difference between the engineer of today and the engineer of two decades ago, is represented in a measure by the difference between the slide valve, throttling-governed engine, and the Corliss triple expansion. The increasing complication of power plant apparatus and processes have forced the engineer to become not alone a worker, but a student as well. The good positions are open only to the men who study while they practice.

Not many years ago the salesman went to the office to sell packings, oils, etc., now he makes a bee line for the engine room, for he knows that he will be sent there anyway. Generally, when new equipment is to be ordered, the engineer has the last and the deciding word.

In short, from a comparative nonenity, the engineer has become all that is representative of the best citizenship in every community.

*Abstract of paper read before the Southwestern Ice Association.

IN ORDER THAT the condensed steam, etc., may have the same direction of flow as the steam, horizontal steam pipes, whether for power or heating, should always pitch downward from the boiler.

INSULATION*

Some Fallacies About "Dead Air Space" for Refrigeration Insulation, Value and Durability of Different Materials

By E. R. Norris

MOST any material might be used for insulation if it were possible to use enough of it, but with materials of low insulating efficiency, it becomes necessary to use heavy insulation at great cost both for material and for erection. For an illustration we may state that a brick wall 90 in. thick, built of brick of average quality and dryness, would have an insulating efficiency approximately equal to a 17-in. brick wall and 4 in. of Nonpareil corkboard. Of course, no such brick wall has ever been built for the purpose of insulation, and it is highly improbable that anyone would ever consider so doing. But until a few years ago the common practice in cold storage insulation was almost as bad.

In the early days of refrigeration the science of insulation was not given any particular attention, and the earlier ice plants were erected with any makeshift insulation that might be at hand. Cinders were quite often used under and around the freezing tank, and in the Southern territories cotton-seed hulls were handy and were used for a similar purpose. In the ice-storage rooms hollow walls were sometimes built and filled with cinders, shavings, sawdust or cotton-seed hulls, but the most common practice in large cold storage work was the use of the so-called "dead air space" construction.

This usually consisted of a series of units, each unit being an air space from one to 2 in. wide, cross-hatched to prevent circulation, and 2 layers of lumber with insulating paper or some form of quilt between. This unit was multiplied until the insulation was supposed to be of the proper efficiency. I say "supposed to be" because until 10 years ago no one had any accurate data on the transmission of such a construction.

Materials and labor in this construction made the first cost so high that it was practically prohibitive to erect an insulation of the proper efficiency, yet we find insulations today that were erected 10 and 15 years ago in which the lining of the brick walls runs from 18 to 24 in. thick.

The greatest error in this construction was found to lie in the fact that the so-called "dead air space" cost more to build properly than it would cost to substitute therefor a single inch of lumber, yet accurate tests shows that the inch of lumber has practically twice the insulating efficiency of the dead air spaces carefully built.

By careful investigation of the heat transmission of various substances, products have been found which have from 2 to 3 times the insulating efficiency of the best lumber obtainable for insulating work. Many of these products are on the market today at a price which compares favorably with a good grade of lumber and the cost of erecting these materials is far less than the cost of putting in the lumber insulation. The lumber must be put in in a number of thicknesses, or layers, while the modern form of insulation is usually applied in 2 layers, or 3 at the extreme. Also lumber does not last; its life in cold storage varies according to local atmospheric conditions and the method of handling the storage rooms to from 4 to 8 years. In extreme cases the lumber has remained in fairly good condition for a longer period, but we can safely say that 6 years is the average life of lumber insulation in the ordinary ice and cold storage plant.

In choosing insulation, either to replace lumber or for a new plant, it should be the object of the buyer to select a material which will withstand the extremely severe conditions incident to cold storage work. In other words, a material should be selected which will maintain its insulating efficiency and not deterioate in use. Moisture is, of course, the great enemy of insulating efficiency, and a test to determine the absorbing powers of any material can be made very easily in a number of ways. Such a test, however, is only an indication of what may occur to the insulation under cold storage conditions.

To gain further knowledge, concerning the life of various insulating materials, in actual use, we have recourse to the results obtained in various plants which have been insulated for a number of years.

After the selection of an insulating material, which will maintain this efficiency, approximately constant for a number of years, it is also absolutely necessary to consider the structural strength of the material and the methods necessary to be used in construction. The structural strength of any insulation does not need to be extremely high, but it must be sufficient to maintain its own weight, and the plaster finish usually employed on walls and ceilings.

A careful study should be made of the methods of construction to be employed in connection with insulation, as some materials are well adapted to certain types of construction, while others, similar in form, but vastly different in character, cannot be used in these constructions. For instance, it has now become a practice to insulate concrete ceilings and sometimes walls, by placing insulation slabs inside concrete forms before concrete is poured. This construction is admirable with some materials, while with others we believe to attempt to use it would result in disaster.

Nothing but pure Portland cement and a good grade of sand should be used for the plastering of cold storage insulation. None of the other plasters which contain lime, putty, or gypsum, will answer the purpose. It is impossible to prevent the Portland cement plaster from cracking, but, notwithstanding the fact, it is the only plaster which should be used.

In regard to the matter of cracking, Mr. Mayhew stated from his own experience that the best thing to prevent it was to use soap to finish the last coat, mixing the cement with soapy water. Mr. Norris said that one trouble in plastering over cork was that the plasterer was likely to work too hard and apply the plaster as he would to a lathed wall, while with the cork an entirely different method was necessary.

Mr. C. A. Tatum also discussed the matter of plastering, and advised the use of a piece of ingrain carpet on a float for the surfacing instead of a trowel. He recommended whitewash used by the government light house service.

Mr. R. C. McCoy advocates the scoring of plaster to prevent cracks, stating that the method used by his company was to score entirely through the insulation.

*Abstract of paper before the Southwestern Ice Association.

The semi-annual meeting of the National Cotton Manufacturers' Ass'n. will be held in Paul Revere Hall, Mechanics' Building, Boston, Mass., Apr. 24 and 25. Papers will be presented on various topics dealing with the manufacture of cotton and textiles, including one on Steam Efficiency in Textile Plants and one on Transmission of Power by Rope.

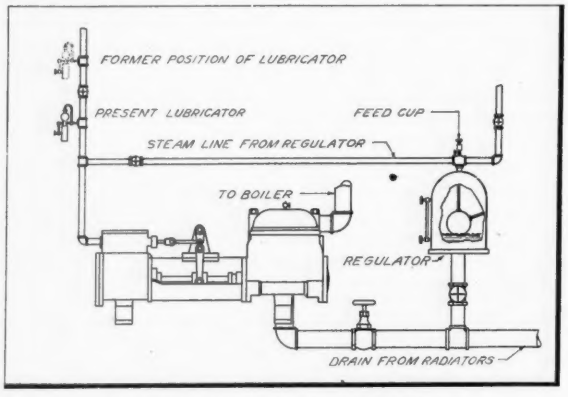
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

RELOCATING LUBRICATOR

SEVERAL years ago when I took charge of the plant which I am operating in a 14-story office building, there had been a great deal of trouble with a regulating valve on the boiler feed pump, which pumped the return water from the heating system back into the boiler. The pump would stop and was usually difficult to start again. The pump worked automatically, when the line was pumped out, the pump would stop as the float in the regulator would drop, cutting off the steam, then when the line filled up again the regulator would open the valve and start the pump.

The steam line to the pump had 2 branches, one went direct to the pump from the boiler, while the other led through the regulating valve. When the automatic system was used the valve in the direct line was closed. The main lubricator for the pump I



CHANGED LOCATION OF LUBRICATOR

found was placed above the valve in the direct line, while there was a feed cup on top of the regulator valve, so that when the direct steam line was closed, the only oil that could get to the pump was what would come over from the cup on the regulator valve. The most of that oil going down into the float chamber, the former engineer believed that the regulator valve was sticking causing the pump to stall, and was in the habit of pouring oil into the feed cup by the quart in order to get the pump to work. I discovered that the night operator was in the habit of leaving the direct steam line valve slightly open, allowing the oil from the main lubricator to get down to the pump valves.

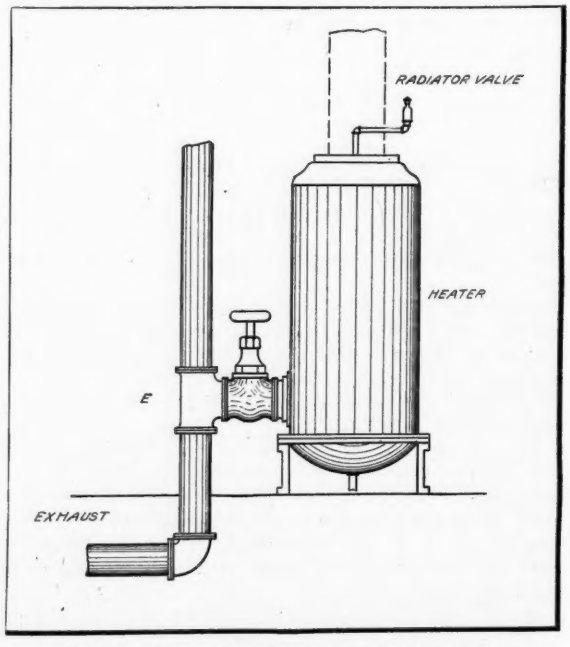
From this I readily saw that the lubricator was in the wrong place, so I at once changed the positions of the lubricator and the main line throttle valve. As will be seen by the sketch, the dotted portion shows the former position of the lubricator. Placing the lubricator below the valve allowed it to feed to the pump valves when either steam valve was closed.

After making this change the use of the feed cup on the regulator was discontinued, and we have never had any trouble with the pump stalling since.

L. M. Johnson.

EFFICIENT HEATER INSTALLATION

HEREWITH is shown how a Berryman type of exhaust steam feed-water heater was connected up. The main exhaust line ran from engine up through a tee to atmosphere, and had a gate valve provided so that the heater could be connected in and a blank flange was placed on top of the heater, which had an opening made through it so that an ordinary indicator air valve could be connected as shown. The idea of this was to allow the escape of the air from the heater and allow the exhaust steam to come in contact with the coils.



HEATER CONNECTION AND ITS IMPROVEMENT

This air valve arrangement worked all right as far as it was concerned, but the efficiency of the heater was raised about 50 per cent when it was properly connected to an ell placed where the felting E is shown. The valve was done away with and the exhaust line to atmosphere was connected to the top of the heater as shown by the dotted lines. This gives the steam a good heating effect upon the water coils as the coils stand in a vertical position and the exhaust steam entering the side of the heater comes in direct contact with them causing a better heating effect. The method used in connecting this heater is one suggested by a college trained man while the latter is a common practice.

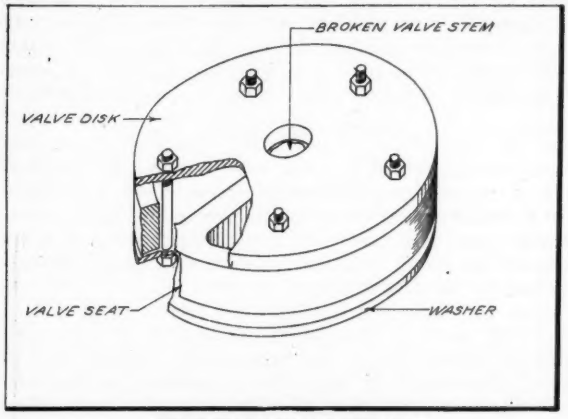
C. R. McGahey.

AN EMERGENCY PUMP VALVE REPAIR

OUR Fairbanks Morse compound duplex pump of 500 gal. per min. rated capacity, pumps to a tower of 60,000 gal. capacity, 130 ft. above pump. On a Thursday afternoon the valves and pistons showed signs of giving out. The heads were taken off and not having any valves or coil packing for the pistons on hand, some packing used on the rods was used to fill up the bad spots in the pistons, and when started pumped about 100 gal. a minute without pounding. This was enough to keep up the supply and by 10 o'clock in the morning I had the tower full enough to leave.

I went to Chicago and bought 3 dozen new valves and 2 boxes of coil packing. At 3 o'clock I was back and had the pump running. At 10 o'clock one valve gave way entirely and the pump was almost immediately opened and work commenced.

In taking out the valve stems I broke two of



TEMPORARY VALVE REPAIR.

them. After all the others were back in place a new valve was put over the valve seat and when taken away showed the impression of the valve seat. Then 5 holes were drilled in the valve disks to correspond with the open spaces and 5 holes were likewise drilled in 2 large washers. Then they were bolted in place, as shown in the illustration. There were 4 valves to a set, 16 to a cylinder, or 32 in the pump, so that the loss of 1 valve on each of the 2 opposite discharge ends of one cylinder, did not make a material difference. The pistons were repacked and the whole started at 6:30 Saturday morning just as the tower went empty. New valve stems were ordered but the temporary repair is still doing duty, some 8 months since the accident.

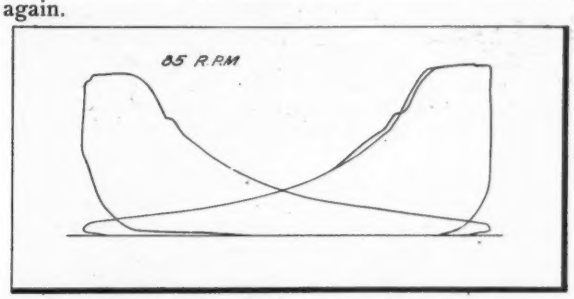
C. R. Curtis.

POWER FROM FLYWHEELS; EFFICIENT OIL BURNING

I AM enclosing a card from one of my engines, a 16 by 36 E. P. Allis, and considering that this is one of the first engines made by this firm, it having been run almost contsantly since it was first erected, the only times when not in motion being when it was moved from one part of the country to another, it being now on its fifth foundation, having no new parts except radial rod brasses, one new crank brass, and one new steam bonnet, in all these years, the flywheel being out of round ¾ in., it having gone through a fire; I say, considering all this, I am vain enough to think it takes a very good card.

At times this engine has no load, and then instantly has a 50 per cent overload, walking right through with it, and doing it so quietly and nice, never running hot, or paying much attention to water, in case the fireman gets his water level a little high, I think that I have yet, although she is old enough to be retired, a very good old mill.

I have been a constant reader of Practical Engineer for a number of years, and while I always read the paper through, absorbing now and then some real good point by some of our practical letter men, yet often I am puzzled, and at times much amused, by some of their ways of getting around old man Trouble. At times amused, because their explanations are so simple, or else so out of reason. At times puzzled, because I myself am at fault, and not being able to see clearly, and in attempting to carry out their lines of reasoning, by putting them to a practical test, I fall down, though in nearly every case, make several attempts to justify their statements by blaming my failures and trying again.



A GOOD CARD FROM AN OLD TIME CORLISS

But in the February 1 number, I find a statement that is giving me lots of worry, and causing considerable serious thinking. It is this article of Brother Newman's. Bill says he has a motor. He has that motor to pull a saw. His load, peak, is 140 amp; his load, empty, is 140 amp; he goes ahead and does his work for nothing, it seems, for it surely costs just as much to run his motor empty, as it pulls 140 amp. empty, same as loaded, as it does to pull it loaded.

Honestly, now, Bill, don't you think that your ammeter hand got hung up on you, or does it really do it?

And say, why don't some of you fellows tell us how to burn oil? For years I've been making all kinds of experiments, testing out every new idea, and spending the boss's money, trying to get it down pat. And I thought that it was mine, safe in my hand, until a few weeks ago, when I read a statement of the college engineer at Stillwater, Okla., and he evaporates nearly twice as much water, in gallons, as I can get out of the same grade and kind of oil, per gallon of oil. I have traveled over Kansas, Texas, Oklahoma, Missouri and part of Arkansas, and all in the effort to learn how to burn oil, and I'm doing as good as the best of them; yet here comes this college man and says it's only half good enough. So speak up, brothers, and teach me what you can, for I'm a willing candidate, and hope I'll make a fair scholar.

John Pierce.

ENGINE REVOLUTION GAGE

IN the February 1st issue there appeared an interesting article by Edgar G. Schindler, with sketch showing a device for the purpose of indicating the speed of engines, the device consisting of a graduated scale, with pointer actuated from the block on the vertical shaft of a Corliss governor, which he described as

being attached to a 125-ton ice machine. It would be interesting to know just how his speed changing device of the governor is arranged, and also upon what style of Corliss governor he is able to make this device work successfully. It is possible that it is a spring loaded governor with spring tensioned from some fixed point, in which case it might possibly work, but it is more likely that it is a governor with sliding weights on the governor arm, and as most 125-ton ice machine are equipped with the latter, we will assume that his engine is so equipped.

Now, theoretically, this device ought to work—or perhaps I ought to put it that at first thought it ought to work—but there are some reasons why, in common practice, it will not perform the function for which it is intended.

It is a case of 2 forces working in opposite directions, i. e., when the weights on the arm of the gov-

BABBITT TAKEN FROM AIR COMPRESSOR CYLINDER

ernor are moved in the direction to speed the engine up, it has a tendency to lower the governor shaft, and consequently lower the pointer, and at the same time to raise the trip blocks on the admission valves, and admit more steam to the cylinder which speeds the engine up. This accelerated motion is immediately transmitted to the governor flyballs, and their centrifugal force is exerted in the opposite direction—force against force—with the ultimate result that the pointer is in almost exactly the same position as before. Reverse the operation, and the conditions will be reversed, with exactly the same result. Of course these conditions apply when the engine is up to speed and the governor has gained its equilibrium.

This device would doubtless work successfully on a throttling governor, or a governor equipped with a Sawyer valve, but the writer is inclined to the belief that it would not be a success on a Corliss engine driven ice machine, and the conditions would be the same on an engine driving a dynamo, with the slight difference that when the engine is up to speed and running light, or with a light load, the governor would ride slightly higher than normal, and when the load is put on it would settle back to very nearly its original position, so nearly so that it would be difficult to graduate a scale so it would be of much practical use.

I should like to know Mr. Shindler's views on this question and further details in regard to the governor.

Geo. Van Vlack.

A BABBITT COMPRESSOR

IN the illustration is shown a chunk of babbitt before and after it got into an air compressor. The hammer was the only thing that the photographer had with which to compare the size of the babbitt. One squeeze did the job as illustrated. G. H. Wallace.

OHIO LICENSE LAW

IN regard to "Defects in Ohio License Law," page 375 of April 1st, 1912, issue of Practical Engineer, I would say that we now have a state boiler inspection law which went into effect Jan. 1st, 1912. Section 2 reads as follows: On and after Jan. 1, 1912, all steam boilers and their appurtenances, except boilers of railroad locomotives, portables used in pumping, heating, steaming and drilling, in the open field, for water, gas or oil, and portable boilers used for agricultural purposes and in construction of and repairs of public roads, railroads, and bridges, boilers on automobiles, boilers of steam fire engines brought into the state for temporary use in time of emergency for the purpose of checking conflagrations, boilers carrying pressures of less than 15 lb. per square inch, which are equipped with safety devices approved by the board of boiler rules, and boilers under the jurisdiction of the United States, shall be thoroughly inspected, internally and externally, and under operating conditions at intervals of not more than 1 yr., and shall not be operated at pressures in excess of the safe working pressure stated in the certificate of inspection hereinafter mentioned, and shall be equipped with such appliances to insure safety of operation as shall be prescribed by the board of boiler rules.

We also have specifications for constructing boilers, about the same as Massachusetts. Sec. 7, which reads: When a person desires to manufacture a special type of boiler, the design of which is not covered by the rules formulated by the board of boiler rules, he shall submit drawings and specifications of such boiler to said board which may permit the installation of the same in the state of Ohio.

It costs the owner $5 per boiler for state inspection. I think Sec. 2 is somewhat lenient yet, and in regard to the grading of the different classes of license I am of the opinion this ought not to be done, as I have personally known men holding first class license who were not as capable as some holding third class. The only reason for the different classes being some cannot express their knowledge in writing as well as others.

I have been employed under a chief holding a first class license of Ohio and I myself holding the same grade, but I do not consider myself on an equal with him; neither can I see why carelessness in a 500-hp. plant cannot do about as much damage as in a 1000-hp. plant. I think this is a very hard proposition for us to decide so as to give every man his just dues.

Roy Stahl.

SCALE IN HEATER

IN the plant where I am employed, we have a Berryman feed water heater and a duplex boiler feed pump. The heater is of the closed type and the feed water has contact with the outside of the nest of tubes around which it passes and absorbs heat from the exhaust steam which passes through the inside of the heater tubes.

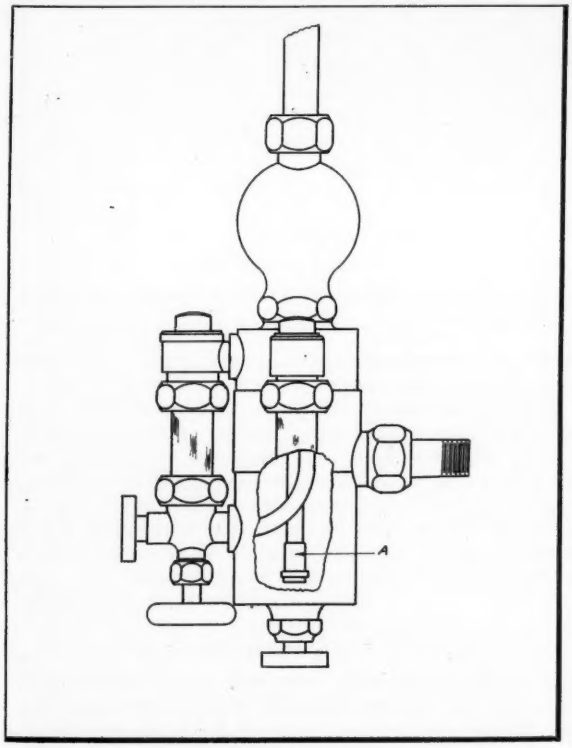
Considerable scale therefore accumulates on the water side of these tubes from the hard water which is used, and in this particular case shells off and falls to the bottom of the heater, some of the scale becoming ⅛ in. thick before it falls off and breaks up into trough shaped chunks not small enough to blow through the blowoff;

consequently the heater should be frequently opened and cleaned. This one had not been cleaned in 9 months of continuous service, simply because it did not need it, so the powers said. I complained many times that the enormous accumulation of scale in the case of the heater was overworking our pump. It wouldn't hurt any if the heater was full of scale, so says the chief. But we opened the heater recently for cleaning and found scale piled up to a height of 30 in. above the tube sheet, 24 in. above the inlet connection of the feed lines from the pump. One of the workmen told me that the heater on several occasions had twice that amount of scale in it.

I have not been able to convince the boss that the scale impeded the flow of water through the heater. There isn't any way to determine exactly the amount of friction in pounds that this scale offered to the passage of the feed water, unless we tap the feed line between the pump and heater and attach a pressure gage. But I estimated that 15 per cent of the boiler pressure was about correct; boiler pressure 140 lb. gage would give 161 lb. at the pump. I would greatly appreciate it if some of the readers would give their opinions in this matter. Thos. C. Robinson.

LUBRICATOR IMPROVEMENT

IN Practical Engineer for March 1, Mr. Boyer suggests that I had not done justice to the method of filling a lubricator as described in the issue for January 15. Evidently he has a different type of lubricator in mind when he says that the operation of the lubricator need not be



LUBRICATOR SHOWING LOCATION OF BALL CHECK

arrested while being filled, for the lubricator I have has a ball check in the pipe running from the condenser to the oil chamber which prevents the condensate from backing up into the condenser.

This is a Detroit lubricator the arrangement being as shown in the sketch. Martin McGerry.

BOILER EXPLOSION HAVOC

A MOST destructive explosion occurred in Bond, Miss., at the lumber company's plant during the latter part of March. This plant is one of the largest saw mills in the state and the explosion was so disasterous that it completely wrecked the boiler and power plant killing 5 men who happened to be the only ones in the vicinity at the time.

The plant consisted of 12 tubular boilers and at the time of the explosion the boiler which blew up had been cooled down and washed out the night before and it is supposed that high pressure steam was turned into it from one of the other boilers while the water in it was still cold. Several bad explosions have occurred in Mississippi during the past year or so and in every case this same condition of affairs has prevailed so that firemen and engineers should take warning and be careful when cutting boilers together.

WRECKED PLANT AT BOND, MISS.

In order that definite information may be gained as to the causes of boiler explosion an investigation should be made of every serious explosion considering the weights, shape, provisions and directions of the scattered pieces so that the original place of these pieces may be known and the forces which acted may be estimated. Usually the first may be discovered by comparison and from the direction taken by the heavier pieces as light pieces usually take the direction of the escaping steam while the heavier parts take the opposite direction due to the reaction. Careful examination for thickness of plates, amount of corrosion, condition of plates and condition of facture will usually show cause. J. B. McDevitt.

A RECONSTRUCTION NEEDED

THEY were short on help in the boiler room and the chief engineer sent down a negro, who had been a hand fireman at one time. The foreman, after much coaching finally got him so he could keep his steam pressure up after a fashion, with the chain grate stokers.

Several days afterward the chief came into the boiler room.

"How are you getting along, Johnson?" he asked.

"Fine, sah, fine," replied the colored man with enthusiasm.

"Let me see one of your fires," said the chief.

"Yas, sah," said Johnson, opening a door, and revealing a bare grate on one side and a pile of unburned coal on the other.

"What is the matter that you can't run that fire straight?" demanded the chief, and he forthwith gave a 5-minute lecture on the operation of chain grate stokers.

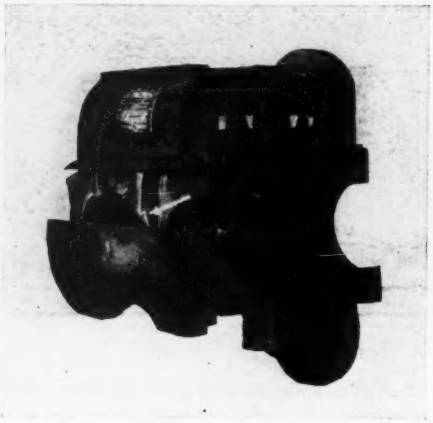
Johnson listened with great attention until he had finished, and then said with great solemnity.

"Wall, you see, boss, dat night man done started dat ar fire crooked, an Ah guess 'bout all Ah can do am to stop hur, an start hur all ober agin, straight."

Dan Royer.

FINDING DEFECT IN PUMP CASTING

WE have here at the Institute a 6 and 4 by 6-in. duplex steam pump which has given a deal of trouble. At first it began to run uneven, that is, it would take a long stroke on one side and a short stroke on the other side. Sometimes it would be shortstroking on one side and sometimes on the other. We tried putting in new piston packing, but that made no difference. Then we tried loosening the packing on the side which took a short stroke, and it was improved a little, but not permanently. We tried tightening the piston packing on first one side,



DEFECT IN PUMP CASTING

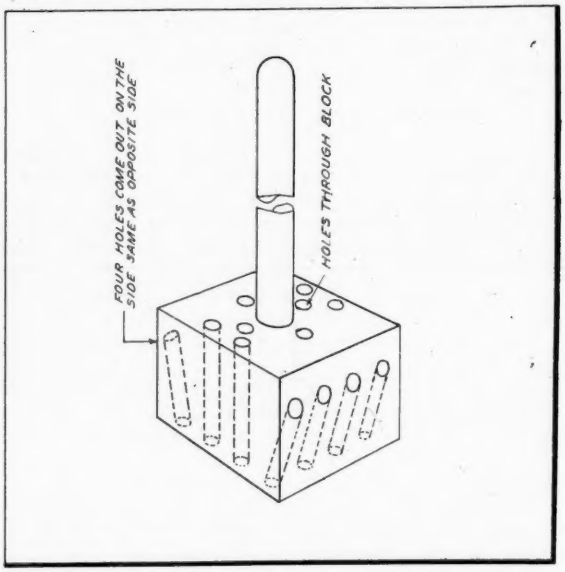
them with a stick and connect a small hose to a steam long run. Then the steam piston was looked over to see if the nut on the end of the rod was loose, but no, it was as tight as ever.

The valves in the steam end were adjusted and then the valves in the water end were faced up and some of them replaced and the packing on the upper valve deck changed and the pump again tried. In fact, it was tried between every operation, and this last time, when it was running, we could hear the water in the water end rushing through the valve chamber at each stroke, sounding as though it was leaking from one piston to the other, so off came the valve cover again, and while we were looking at it (the whole water end up to the discharge chamber being full of water), I tried to lift up one of the discharge valves, and when I put my hand into the valve chamber on one side of the pump, the water would move in the other side, thus showing that there was a connection between the 2 cylinders somewhere down in the pump. In order to find it, we next took off the cylinder heads and poured water down the end ports of the pump, stopping up the ports one at a time in the cylinders, and found that water which was poured into the port of one cylinder would run into the opposite cylinder, thus showing that there was a connection between the ports of the 2 cylinders. We next took off the water end entirely and put on a new one and took the old one in the shop and planed off part of the end in order to see the defective ports. We found that the ports on both ends of the pump were connected together, the casting being defective at that point. The illustration will show the front end of the pump with part of it planed away on purpose to show the defective port. The arrow points to the defective partition. It might possibly have been plugged with babbitt metal, but we needed the water end of the pump for instruction here at the school, so thought best to get a new one.

S. E. Balcom.

WASHING OVERALLS

THE question was asked some time ago for a good way to wash overalls; at the plant where I am, we take a wash tub and fill it about ½ full of overalls, etc., rubbed or soaked with soft soap; it is the soap that the janitor uses for cleaning floors. After the overalls are in the tub we add warm water just to overflow them. We let them stand for about 2 hr., then stir



VIEWS OF TAMPER USED IN WASHING OVERALLS

them with a stick and connect a small hose to a steam pipe and put one end of it in the bottom of the tub. Just turn on enough steam to heat them. After the hose has been in for about ½ hr. stamp the clothes good with a stick; we have a block about 3 in. each way bored full of holes and attached to a broom handle. After you have stamped it every ½ hr. for about 3 hr. take them out and rinse them good till the water is clear, then dry them; you will be surprised to see the results at such a small expense.

Wm. H. Kuchenbrod.

FUN IN THE POWER PLANT

ARTICLES appearing now and then concerning the many funny incidents that happen in and around the power plants tend to bring to light the varying phases of human life. The enactment of many of them serves in a measure to temper the monotony of the long hours of steady grind that come to the employees in the plant. The following incidents are not given as examples to be followed, but solely for their humor.

An engineer accepted a position in a plant in which was a large Corliss engine heavily loaded, and owing

to the nature of the load it was practically all on when the engine was shut down, necessitating quick work on the part of the engineer in keeping it off center. The engineer in question had quite a lot to learn, especially concerning the handling of Corliss engines, but had unlimited confidence in himself.

After being informed of the task of rolling the engine off the center, and watching and receiving instructions from the other engineers he was placed on duty. As fate would have it he was called on to shut this engine down during his first run. The various employees had a penchant for gathering in the windows and doors of the engine room on occasions like this to see how the new engineer would perform.

He went about the task a bit nervous and totally oblivious to the many pairs of eyes being focussed on him. He closed the throttle and then ensued a brief but fierce struggle in getting the starting bar in place. By this time the engine was almost stopped, and summoning all the strength at his command, he gave the bar a powerful upward yank, and in so doing he pulled it out of its socket, and after performing a backward somersault landed in a heap between 2 oil tanks. He arose amid laughter from those watching him, and minus practically all his conceit. After receiving 1 or 2 similar falls he began to learn, but it was always with many misgivings attending him that he stopped this engine.

One of the proprietors of a flour mill stood near a stand of rolls while conversing with the miller. Explaining his conversation by partly bending forward, he thereby brought his coat tail between the belt and pulley. By intuition he seemed to realize what had him as he felt his coat jerk in passing over the first pulley. Immediately he seized the miller around the neck shouting, "save me, save me." But he had saved himself, and also his coat, although it was a very abbreviated affair compared to its former ample proportions.

The firemen in a plant were working like beavers to keep up steam, when a denizen of the backwoods stepped in the boiler room and said he was a No. 1 fireman and looking for a job. After asking several ridiculous questions he added, "What does these bilers bust at?" Emphasizing his answer with an oath the head fireman said he didn't know, and he didn't want to be there when they "busted" to find out either.

One night, a fireman's helper came through the engine room on a high gear, gesticulating wildly and on finding the outside door locked frantically called for the key. On asking him what the trouble was, he said one of the boilers was blowing up. He had been busily engaged pulling ash from the ashpits, when a gage glass immediately above him had burst, thus starting him on his marathon fete.

Told to order a barrel of cylinder oil and one of engine oil, a young superintendant wanted to know why 2 kinds were wanted, and as the engineer was unable to make him understand, he informed the engineer that he could have either kind he wanted, but not both. Two barrels of cylinder oil were ordered.

A few days ago a very knowing sort of a fellow went into an engine room and asked the engineer if he had a short piece of pipe or rod a little smaller in diameter than ¼ in. When the engineer asked him how much less than ¼ in. he wanted, he said he guessed 2/8 in. would be about right.

Jos. Stewart.

OILING THE CRANK PIN; GRINDING IN RUBBER PUMP VALVES

DUE to the breaking of the oil spout that carries oil from the cup to the crank pin oiler a hot bearing and consequent shut down seemed inevitable until I thought of the following scheme. I raised the oil stand C and ran a wire from the bottom of the oil

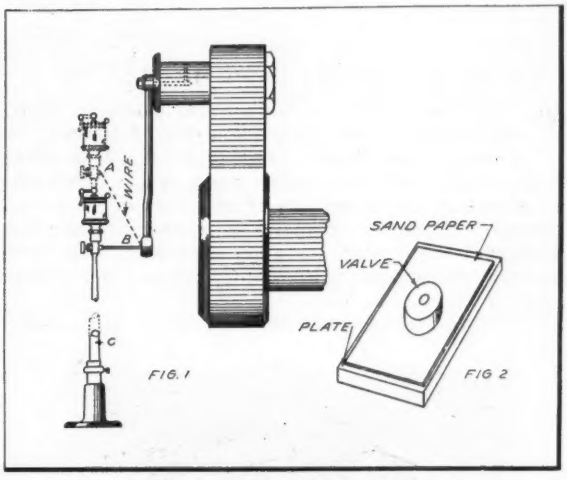


FIG. 1. EMERGENCY OILER
FIG. 2. GRINDING RUBBER VALVE

cup A to the crank pin oiler B. The drops of oil follow the wire by capillary attraction but the scheme works better if the wire is wrapped with a few fine strands of waste. The device was put to work while the engine was still in operation.

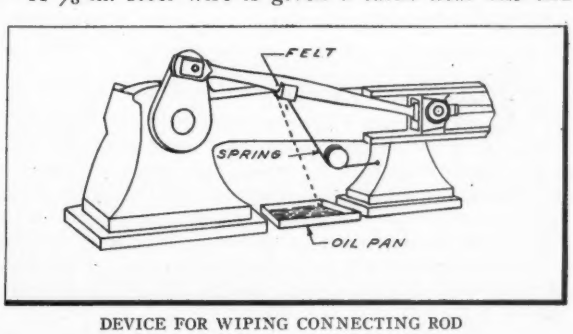
A worn rubber pump valve can be made to work as well as new by grinding it with sand paper. Place a sheet of No. ½ or 1 sandpaper on a smooth surface, a face plate is best, and rub the valve disk over the paper until the surface is perfectly smooth.

Edward Lamberson.

CONNECTING ROD WIPER

ANNOYANCE caused by oil being thrown from the connecting rod of an open crank engine has been overcome in our plant by the device shown in the illustration.

A ⅛-in. steel wire is given 3 turns near one end



DEVICE FOR WIPING CONNECTING ROD

which is inserted in a hole in the guide post, the other end carries a stiff felt wiper 1 in. wide which encircles the connecting rod about half way and is held against the rod while it is in motion by the tension of the spring. When the engine is running the oil is wiped off the connecting rod and falls into the pan beneath it, as shown by the arrow. Wm. G. Erdon.

Questions Answered and For Answer

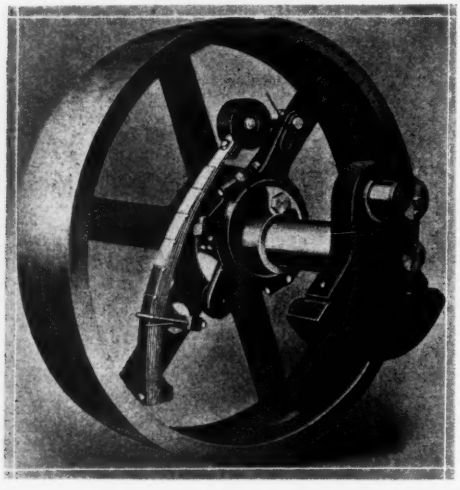
Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Adjustment of Armstrong Governor

WHAT is the purpose of the adjustment marked on the enclosed governor illustration? H. M. M.

A. The adjustment referred to in the illustration showing the Armstrong shaft governor, is for the purpose of changing the position of the eccentric arm, relative to the spring, which is done by changing the link pin from one to other of the series of holes in the arm.

To get closer regulation, and more sensitiveness,



ARMSTRONG GOVERNOR SHOWING MEANS FOR ADJUSTMENT

move the pin in the eccentric arm closer to the shaft center.

To make governor more sluggish, and put a stop to racing, move the pin toward the rim of the wheel.

C. F. Swingle.

Ignition from Electric Light Circuit

I WANT to furnish ignition current for a 3-cylinder oil engine which is now running on 6 dry cells using a Thordarsen coil, make and break plan. I want to use current from a 220-volt circuit and want to know how many lamps to use for resistance, whether the coil I have should be used and whether the grounding interferes with the 220-volt circuit. I want as good strong spark as possible as the current costs us nothing only the expense of generation. C. D.

A. You do not state whether your current available is direct or alternating. If it is direct you can apply it in place of the battery current, by using a resistance in series, but it is going to take a pretty large lamp battery. A 220-volt lamp takes normally ¼-ampere. It would, therefore, take 8 to 10 lamps in parallel to give you the current probably needed in your ignition circuit.

We cannot tell positively about this, because the amount of current that you are taking is uncertain, but usually about 2 amperes is sufficient current on a make and break system. The lamps used as resistance would not take quite as much current as they would if used straight, so that we would probably have to allow a couple of extra lamps in parallel to get the current necessary.

The whole matter will have to be one of more or less experimenting, because of the uncertainty as to the current that your ignition coil is taking. I should start with 6 lamps in parallel and then add others until the spark comes up to a satisfactory point. In this case the coil would be used the same as with the batteries.

I assume that you have a distributor on your 3-cylinder engine so that the spark is timed right for the 3 cylinders as the cranks are set, or else that you have a make and break commutator which is correctly set to accomplish this purpose.

In case you have alternating current on the 220-volt circuit, the most economical method of handling the ignition is by means of a transformer with a make and break in the secondary. In this case you would need no resistance as you could have the voltage on the secondary the right amount to give you the necessary spark. Such a transformer would best be made by a regular maker, such as the General Electric Co. or the Westinghouse Co., who make similar transformers for bell ringing purposes. The secondary voltage should be about 10 or 12.

It may be that by using a lamp resistance in series with the coil you already have, you would be able to get the desired spark from an alternating current circuit, but I should anticipate trouble and you would probably need to connect a condenser in parallel with your coil.

The number of 220-volt lamps you would have to put in parallel would depend on the self-induction of your coil, and there is no way of even guessing what that might be. You would probably need to start with, say, 6 lamps in parallel, and it might be that you would use 12 in parallel or 20 before you got the desired spark, or it might be that you could not get it at all. The only way to try this would be to add one lamp in parallel at a time until you had determined the possibility or impossibility of securing a result. In any case you will realize that it would inovlve a considerable outlay for lamps to get such a resistance.

A. L. R.

Logging Engine and Pump Questions

I AM running a logging engine with 10 in. by 12 in. cylinders and plain slide valve cutting off at 75 per cent stroke. The eccentrics and crank disks are cast in one piece and there is no lead. Wouldn't it develop more power if it had some lead? At what percentage of the stroke should the exhause port close and what is the rule for finding the exhaust lap?

While in New Westminster, B. C., taking an examination for an engineer's license I saw a young man who was asked the question, If a rod in one side of a duplex pump was broken could you keep the other side running? He answered no and was denied a license. Is there any way that it could be done? W. C.

A. Your logging engine should have at least a small amount of lead, but as the eccentrics and crank disks are cast in one piece it would require considerable machine work to give the eccentrics the necessary angular advance. So far as adding to the power of the engine is concerned there would be very little gained, that is, provided the valves are at present adjusted to admit steam at the beginning of the stroke. The principle object aimed at in giving a valve lead is to supply a cushion of live steam, which, in conjunction with that already confined in the clearance space by compression shall serve to bring the moving parts of the engine to rest quietly at the end of the stroke, and also quicken the action of the piston in beginning the return stroke.

The exhaust port for high speed engines should be closed when the piston is at a point not later than 90 per cent of the stroke.

As to operating a duplex pump having a broken rod on one side, the matter depends upon the character of the break. Of course if a rod or lever directly connected with the operation of the steam end should get broken it would be necessary to stop the pump until the break could be repaired. If, however, the piston rod should get broken inside the water end, the water piston could be taken out, the water cylinder again closed, and if the rod was still in a condition that permitted of its being moved back and forth in its glands, the pump could still be made to pump water with the other side by simply screwing up the packing glands on the broken rod tight enough to cause the friction needed to prevent a jerky motion of the rod. The tappets that operate the steam valve on the broken side should also be adjusted to cut off very short, since all the steam that will be required on that side is merely enough to move the piston rod to and fro so that it may in turn impart motion to the steam valve on the good side.

In some cases it might become necessary to remove the packing rings from the steam piston on the broken side, thus allowing steam to blow past the piston in order to reduce its speed to the required rate.

Piping in Tile Drier

I AM sending you a sketch of a drying system which I wish to change. It has never given satisfaction by the old method.

I claim that I will get twice the heat from the new system that I get the old way, but they claim I will have trouble keeping the mains and risers from filling up with water. You will note the drain in the main in the new system, is it in the proper place?

I also do away with the cast iron headers in the new system, and drain direct to the 2-in. pipe and then to trap. I carry 5 to 7 lb. back pressure on the engine. By the new way I get my steam distributed at the nearest point to engine, where in the old system it went to the farthest end of the drier before being put to work, and then it made but one circuit.

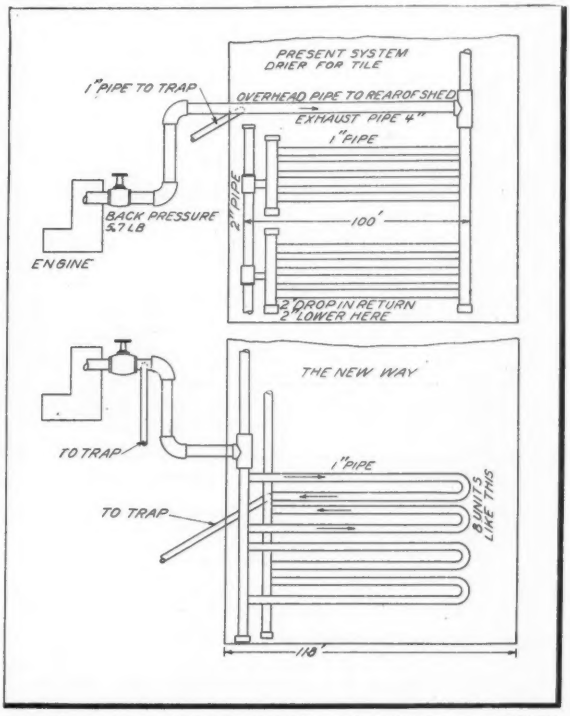
In the new system the 1-in. risers have a grade of 2 ft. to 100. And the returns a fall of the same; that is why they claim that I will have trouble in keeping the 4-in. main from filling with water.

Would it be best to put more drains in the 4-in. riser, and if so, where? F. W.

A. Placing a drain at the bottom of the 4-in. riser would be necessary in addition to the drain already there at the engine, because the riser furnishing steam needs to be freed of water at its lowest point and as near the drier as possible, or there will be a column of water in it which will hold back the steam from entering into the drying pipes, especially as the supply pressure is not high.

In the new system as shown on the sketch, I assume that the 1-in. pipes start from the header and slant downward 2 ft. to the return bend and from the return bend, slant downward 2 ft. to the discharge header, and these pipes are over 100 ft. long each way.

I do not think there would be any difficulty in getting steam enough through the pipe to heat it hot all the way through with dry steam at 7 lb. pressure above atmosphere to start with, that is, if there is no fan to cause a strong draft over the pipes, in other words, the heating coil is used as direct radiation only.



PRESENT AND PROPOSED SYSTEM FOR PIPING TILE DRIER

I find that each 1-in. pipe will call for about ½ lb. of steam per minute for heat which is equal to 9 cu. ft. per minute, or $9 \div 60 = 0.15$ cu. ft. of steam per second, at 7 lb. pressure above atmosphere. Now, the area of opening of a 1-in. pipe $= 0.7854 \div 144$ sq. ft. $=$ 0.00545 sq. ft., and the velocity of steam entering the pipe would be $0.15 \div .00545$ ft. per second, which is 27.5 ft. per second velocity, which is not bad, though it makes a pretty long run of 1-in. pipe and in that respect is not as good as the old system.

The steam header should be 4-in. pipe or 3-in. at the least.

The drain from the riser and from exhaust pipe should drain through a water seal of 6 ft. in depth before it reaches the trap.

As to the old system, it seems to me that if 1 or 2 air valves were put in the discharge header, or possibly a Webster thermostatic return valve on the return pipe and using a vacuum pump to pump out the returns, that it might be made to work satisfactorily,

because drawing the air out of the pipes causes them to work more efficiently, and sometimes a small coil hot all over will do more work than a larger one partly hot.

The size of pump needed and other data may be found by writing to any steam pump company if you furnish them with the number of feet of 1-in. pipe which you have in your dry room. S. E. Balcom.

Strength of Concrete Footing.

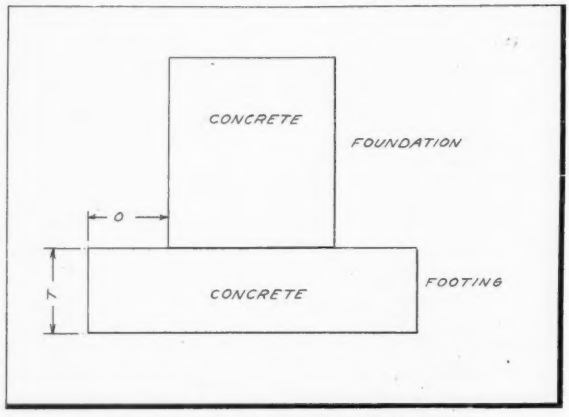
WILL you please solve the following formula. The equation was taken from Masonry Construction, by Baker. Would this formula be correct for concrete?

$$O = \tfrac{1}{7} T \sqrt{\frac{R}{PF}}$$

Where O = the greatest safe offset of the footing course in inches.

T = Thickness of footing not less than 8 in.

R = Modulus of rupture of the material of which the footing is to be composed, in this case 1:2:4 Portland cement at one month, 300 lb. per sq. in.



ELEVATION OF CONCRETE FOUNDATION

P = Pressure in tons per sq. ft. at the bottom of footing, which is 3 tons.

F = Factor of safety = 10. W. H. P.

THE formula which you send is based on the strength of beams and is applicable to any kind of material, so long as the proper modulus of rupture is used. Taking the figures that you have given, R equal to 300, P equal to 3 tons, F to 10, the quantity inside the square root sign becomes $300 \div 3 \times 10$, or 10. The square root of this is 3.16, and dividing this by 7 would give 0.453. The distance, O, from the foundation to the edge of the footing would then be equal to 0.453 times the thickness of the footing. If the footing is made the least allowable depth, 8 in., the length of the offset would be 3.6 in. For a thicker footing the offset could, of course, be greater.

A. L. R.

Thawing Pipes by Electricity

CAN the frozen water line shown in Fig. 1 be thawed by electricity?

2. If so, what connections are necessary?

3. What voltage and what current would be required?

4. I have resistance enough to reduce the voltage to zero. How could I determine the voltage without a portable voltmeter?

5. If the pipe can be thawed out, about how long would it take?

You will notice that there are 2 lines but they both connect to the main switch in the power house.

L. R. S.

A. Thawing a water pipe by electricity has come largely into use.

2. Figure 2 shows the connections. Each side of

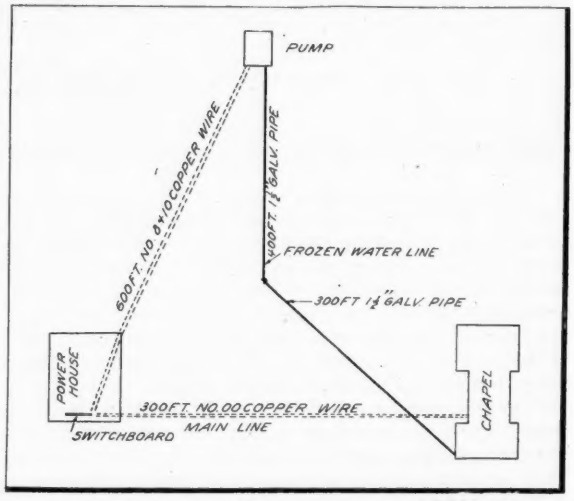


FIG. 1. LOCATION OF ELECTRIC FEEDERS AND FROZEN PIPE

the main line is connected respectively to opposite ends of the frozen pipe, one wire through a rheostat.

3, 4 and 5. You can use the standard voltage of your line and the current required, as given in the Standard Handbook for Electrical Engineers, is 200 amperes for a ½-in. pipe for a period of 10 to 30 min. If you have 1½-in. pipe it would take approximately 2 to 3 times this current. You do not need a voltmeter, but an ammeter is quite essential when performing this operation. It is doubtful if your rheostats are large enough to carry sufficient current for thawing pipes..

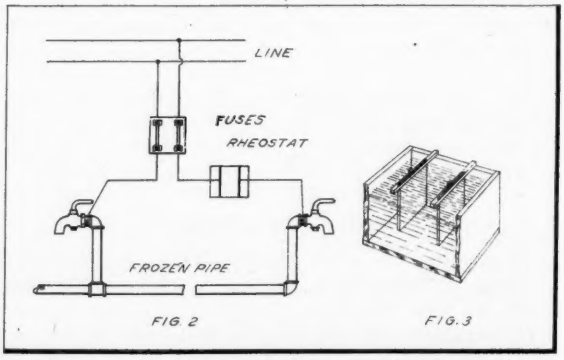


FIG. 2. CONNECTIONS FOR THAWING PIPE

FIG. 3. SECTIONAL VIEW OF TEMPORARY WATER RHEOSTAT

You do not state the voltage of your circuit, but assuming that it is 110, if the resistance were submerged, it would take 62 ft. of No. 5 Brown & Sharp's Gage iron wire. If your rheostat does not prove sufficiently heavy you can make a temporary water rheostat, as shown in Fig. 3, by submerging 2 metal plates in a tub of water, suspending them so that they may be moved backward and forward, thereby increasing or decreasing the distance between them, until the desired current is secured. In low voltage water rheostats, it is customary to add a small amount of sulphuric acid to the water and to allow 400 to 800 cu. in. of solution per hp. continuously absorbed.

N. G. M.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Pump Trouble From Stopped Pipe

I SHOULD say the trouble with E. J. W.'s No. 1 pump is, it is not getting enough steam to pump against boiler pressure. Probably No. 1 pump has been idle most of the time; in such cases steam lines will become stopped up. But here is my experience when I came to my present job: I found an automatic boiler feeder of the S. B. brand, the manufacture of which ceased years ago, and this feeder was discarded shortly after I came here. There was also a 5 by 3 by 6-in. Simplex Union steam pump and injector. The former engineer would trip the feeder every minute or two, and when the water became too low would use injector. I removed the steam valves and cleaned and replaced them. Then it would pump but not against boiler pressure. The ½-in. steam pipe had 6 elbows in it. It was compulsory to have that many but I thought I would put in ¾-in. pipe.

This pump steam line is connected to a 2-in. whistle pipe with a ¾-in. nipple 6 in. long and a globe valve. This valve was kept closed, and it was the nipple I found nearly closed with hardened foam which probably had been carried up when the whistle was blown. Renewing this nipple solved the difficulty and the pump easily feeds a 100-hp. boiler.

John E. Kimbsley asks who ever heard of a boiler being bulged near the front head; if he will visit me I will show him one. I have operated this boiler 2 yr. I clean it every 2 weeks and have found the collection of scale 3½ ft. from the front just 3 times; all other times I have found the scale against the manhole plate which must be forced in, pushing the scale back in order to get the plate out. W. A. Watson.

Expansion Bends

IN Practical Engineer of March 1st, under caption Expansion Bends in Pipe Lines, the writer does not state the length of pipe in the bends, the radius of the bends or where the line is anchored, if anchored at all.

The theoretical amount of expansion for 462 ft. of pipe with saturated steam at 100 lb. gage, is 12.55 in.

From the writer's drawing of pipe line there appears to be approximately 300 ft. between boiler and tee leading to engine No. 1, and 162 ft. between engines Nos. 1 and 2. From his sketch of pipe line I judge he has anchored the tee leading to No. 1 engine securely; or it should be to relieve strain, which would arise if the tee was allowed to move upon the line running to No. 1 engine.

The tee being anchored would cause approximately 8 in. of expansion to fall upon bend which ruptured. The bend between engines Nos. 1 and 2 would have but approximately 4 in. of expansion to care for.

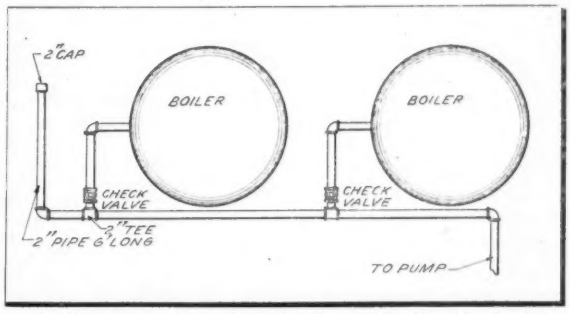
From data on expansion cared for by pipe bends at 12,000 lb. fibre stress, it would require a bend of 30 ft. to care for the 8 in. expansion. This being longer than ordinary pipe lengths, 2 bends of 15 ft. each would be required. One bend of 15 ft. would care for the 4 in. of expansion between engines Nos. 1 and 2.

From the writer's drawing, I conclude that there were not enough bends in pipe line. Steam lines should be anchored to prevent vibrations, which will tend to cause crystalization. C. E. Aldrich.

Pounding of Check Valves

IN Mar. 1 issue of Practical Engineer, N. F. S. does not state if the pipe layout drawing is an "elevation" throughout, but upon that basis suggest he install air chamber consisting of a 2-in. pipe 6 ft. long as shown in figure.

I would recommend a 3-in. suction from heater to pump in preference to the 2-in. already installed,



SUGGESTIONS FOR REMEDYING POUNDING OF CHECK VALVES

as the velocity of water is the same in suction as in discharge as now operated.

Boiler-feed pumps give better results with a piston speed under 60 ft. per minute than over.

If only one side of duplex boiler-feed pumps is tight, in valves, etc., the check valves have a tendency to pound under all circumstances. C. E. Aldrich.

Grinding of Gears

ABOUT that Buick gear which has given V. K. S. trouble, suggestion comes from John P. Durfee, of Drain, Oregon, that if several cups of grease be fed into the dry shaft head marked No. 6 on the lubricating chart and found just back of the transmission case on the drive shaft, it will stop the grind. He suggests the possibility of a rough bearing or broken ball, but states that the method suggested stopped the trouble for him until the season was ended.

From Mr. Stanley we have the solution of his difficulty. He states that in the No. 17 model there is an aluminum gear in mesh with the steel gear that makes contact from slow to intermediate, that the steel gear ground off the teeth of the aluminum gear and that the remedy was to remove the aluminum gear and replace it with a steel gear and the trouble disappeared. The No. 17 model of 1910 is the only one of the Buicks equipped in this way.

PRACTICAL ENGINEER

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Subscription Price One Dollar a year in advance to any Post Office in the United States and Mexico or United States possessions.
To Canada One Dollar and Seventy-five Cents; to Other Countries Two Dollars and Fifty Cents a year. Single copies 10 cents.
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Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois. under the Act of March 3, 1879.

Circulation of this issue, 22,500

CONTENTS

Steam Heating Hints. Illustrated....447
Points on a Vacuum System. By George H. Wallace. Illustrated....451
The "Reliable" Air Line System. Illustrated....454
Buffalo Fan System of Heating. Illustrated....455
The Dunham System of Heating. Illustrated....456
Heating and Mechanical Ventilation. Illustrated....458
The Paul Heating System By S. E. Balcom. Illustrated..460
Tools for Cleaning Boilers. By J. W. Hubbard. Illustrated....462
European Power Plant Progress. By Francis G. Wickware. Illustrated....463
Segregation of Steel....465
Alternating Current Generators. By Carl D. Knight. Illustrated....466
Westinghouse Direct-Current Turbine Generators. Illustrated....468
New Type of Transformer Towers. Illustrated....469
Father MacDougal on Progress....470
Efficiency with Chain Grate Stokers. By Dan L. Royer..472
The Electric Plant at Vitry Sur Seine. By Engineer Nerger. Illustrated....473
Testing Feed Water By James F. Miller....476
Finding Refrigerating Trouble. By Walter C. Edge....477
The Engineer. By William Westerfield....478
Insulation. By E. R. Norris....479
Letters Direct from the Plant: Relocating Lubricator. Efficiency Heater Installation. An Emergency Pump Valve Repair. Power from Flywheels; Efficient Oil Burning. Engine Revolution Gage. A Babbitt Compressor. Ohio License Law. Scale in Heater. Lubricator Improvement. Boiler Explosion Havoc. A Reconstruction Needed. Finding Defect in Pump Casting. Washing Overalls. Fun in the Power Plant. Oiling the Crank Pin; Grinding in Rubber Pump Valves. Connecting Rod Wiper. Illustrated..480
Questions and Answers: Adjustment of Armstrong Governor. Ignition from Electric Light Circuit. Logging Engine and Pump Questions. Piping in Tile Drier. Strength of Concrete Footing. Thawing Pipes by Electricity. Illustrated....486
Problems for Discussion: Pump Trouble from Stopped Pipe. Expansion Bends. Pounding of Check Valves. Grinding of Gears. Illustrated....489
Editorial: The Engineer's Laboratory....490
Supervision. By J. C. Hawkins....491
Sprinkler System in Hart, Shaffner & Marx Building. Illustrated....492
Fire Protection. Illustrated....493
Ventilated Furnace Arch. Illustrated....493
Stickle Thermic Valve. Illustrated....494
Non-Overflow Filler for Hand Oiler. Illustrated....495
News Notes....495
Catalog Notes....496
Trade Notes....498

THE ENGINEER'S LABORATORY

In the course of an engineer's daily work he frequently runs across problems which require more information than he has at his immediate command. His first and natural step is to turn to some handbook on the subject, but as many of us know many of the problems encountered in the practical operation of a plant are not even touched in handbooks or text books. His next step is probably to visit a neighboring plant and find how they do the job over there. It is more than an even chance that when he leaves, the question involved has been discussed pro and con without a correct conclusion having been drawn.

Right here is an opportunity for the engineer to do some experimenting and analyze the conditions involved. Let him use the machinery and implements which he finds in his plant, the things with which the work must be done in all plants of a like character, and starting with certain conditions, vary one condition gradually to both extremes, then vary another condition in the same manner, tabulating the results of each variation. When he has finished this experiment with each condition varied, it is more than likely, if the question involved is of any importance, that the information he has gained will be of immense value to his fellow engineers, to say nothing of the knowledge gained and the satisfaction to the engineer himself.

This plan may be and often is objected to by the engineer because his instruments are not of sufficient accuracy. While this fact may prevent him from deriving empirical formulas for use in accurate determinations it does not keep him from operating his plant and it is the operating conditions that need to be investigated.

Recently the question arose as to what effect different connections to an indicator have upon the shape of the diagram. The question has now been solved and the results will be published in the issue of Practical Engineer for May 15. The method employed is so simple that any engineer who can handle an indicator could have worked out the problem, with no more instruments than an indicator, some piping and a wet rag.

In this issue, Dan L. Royer tells how he has secured greatest efficiency with chain grates. No doubt he arrived at the conclusions he gives through experiment, not of promiscuous character, but by a systematic variation of depth of fuel, speed of grate and draft.

In still another article in this issue Walter C. Edge tells in story form how variations of temperatures and pressures in an absorption refrigeration plant affect the efficiency of the system. Of course, as he states, no two plants can be run with pressures and temperatures the same, so it is up to the engineer in each plant to do some experimenting and ascertain what conditions give best results.

As a matter of fact there are but few power plants

that have not means at hand for determining the exact conditions under which the plant would work to best advantage and knowing these conditions the amount of saving by the desired improvements can readily be calculated, and where the saving is sufficient to warrant the improvement there are few owners who will not authorize the engineer to go ahead.

Can there be anything more important to the engineer in a plant than best operating conditions and highest efficiency? All of these conditions cannot be secured through information from outside the plant, so it is imperative that the engineer use his plant as a laboratory to secure this needed information.

SUPERVISION

Shall it be By Outside Expert or by Expert Chief Engineer

By J. C. Hawkins

IN regard to supervision of the power plant by an outside expert I desire to submit my experience for the benefit of Practical Engineer's readers.

There has been a great deal written in regard to calling in an expert to tell the engineer or rather the boss how to run the steam plant. I had charge of a plant at one time to which an expert was called just shortly after I resigned after 4 yr. of hard work.

During the time I was in charge I kept a close account of the coal used and an approximate record of the water used by checking up the speed of the feed pump which was the only way in this case as the company would not get a feed-water meter.

In addition to this I ran numerous 12 and 24-hr. tests on the boilers taking each boiler alone and then the whole plant, on which occasions I borrowed a meter from the city water works department. I weighed the coal and ash and measured the water and tested the steam and coal for moisture and kept close record of the temperatures, etc., and made the tests as complete as possible. This, with my daily observations, gave my a fair idea of the locations of the weak points of the system. Also I used the indicator on the engines at short intervals and kept the engines in as good shape as possible.

At that time we had 1 11 by 14-in. Buckeye driving a generator, 1 20 by 36-in. Corliss driving a generator, 1 30 by 48-in. Corliss mill engine and 1 32 by 48-in. piston valve mill engine, and got a fairly high efficiency from the whole plant considering the nature of the work and numerous shut downs.

I made a great many changes and improvements and suggested many more that were turned down on the grounds of unnecessary expense. After I left the firm called in 2 professors from a well known engineering college to examine the plant. They looked around a while and said they would have to make a test which they did a few days later in the following manner. They weighed the coal for the whole plant for 8 hr., but did not measure the water, nor weigh the ash. Part of the feed water went through 75-ft. of pipe after it passed the themometer and before it reached the boiler. They took cards every 5 minutes from one of the generator engines, but did not take any from the mill engines which were running intermittently and on a variable load. They measured the draft but not the temperature of the escaping gas nor the moisture in the steam.

I would like to have some expert power plant supervisor tell me how to form any conclusions from such a test if it can be called one. They made 1 or 2 recommendations that I had tried to get through for a year but the things they laid the most stress on for improvement of the plant were to move the steam separator from just above the throttle of the Buckeye engine to a point about 40 ft. back on the same branch and they recommended the scale be cleaned off the pans in the Cochrane feed-water heater to get the water hotter, when as a matter of fact the heater was set so low that the feed pump would not take water at the regular speed at a temperature above 195 deg. while the heater would heat it to 210 deg. or above and it was necessary to admit cold water to the suction of the feed pump to get it to take water. I had advised raising the heater 4 ft. but the experts did not see what for.

They recommended that the firemen be watched and cautioned against throwing coal in the ash pit, while the reason for the coal in the ash pit was that part of the grates which were designed in the plant by a machinist had an air space ⅞ in. wide, of the straight type and would not be discarded till burned out.

The engine they indicated every 5 minutes, used less than ¼ the steam generated by the boiler and was running very nearly perfect with steady load and a large, short steam pipe, instead of indicating one of the large engines which took steam through a long crooked pipe 2 sizes too small, preferably they should have indicated all of them.

There is also a large general service pump located on the river bank running 24 hr. a day, and taking steam through about 1500 ft. of pipe of various sizes, part of which is above the ground, in which is placed 2 reducing valves, and about 1000 ft. has been underground for about 7 yr. and was not very well laid in the first place. I made a calorimeter test of the steam and found it to contain 30¼ per cent moisture at the throttle, and tried to get the firm to install a motor driven centrifugal or power pump as we had plenty of generator capacity and could drive the same horsepower much cheaper than to run steam that distance. They took it up with the experts who said they thought it might be a little cheaper to do as I suggested but did not think it worth while.

Well, after investigating around 2 or 3 days they sent in their report and also a good big bill for services rendered. The superintendent never would tell me what they charged him but he was not very enthusiastic over the bill or the report either.

Any engineer that is in charge of a plant can get sufficient data at little or no expense to himself or employers, which will enable him to make improvements that will put the plant on such a basis that the company will not see any need to call in an expert to tell him what his engineer should have told him.

The engineer is to blame because he does not make an expert of himself on his individual plant thereby being able to make recommendations that will raise the efficiency. And the company is to blame because it does not hire an engineer who is an expert and pay him such wages that will induce him to work for its interest and it should also insist on his giving detailed information at regular times on the operation and efficiency and there should be more conferences between the employer and the engineer in which they can go over the matter together and which will give the engineer more courage to advance any ideas he may have and will create more satisfaction between the employer and the engineer and do away with calling in the expert.

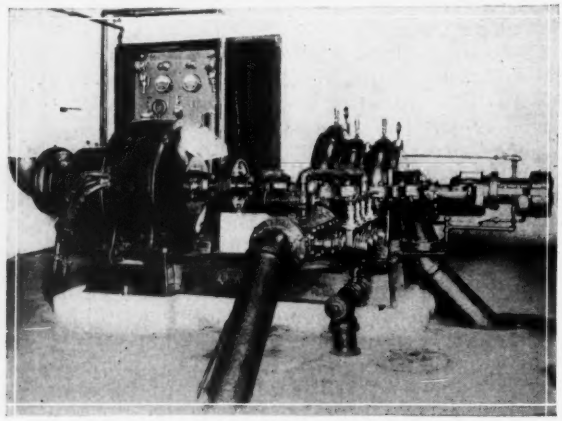
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

SPRINKLER SYSTEM IN HART, SHAFFNER & MARX BUILDING

IN manufacturing plants where a fire is liable to be especially disastrous to both life and property, fire protection is of great importance, not only to save direct fire loss, but also in some cases to comply with regulations of municipalities and in others to reduce the cost of insurance. Plants in which clothing is manufactured belong to this class, and the more progressive manufacturers are not slow to employ the most modern systems of fire protection known.

Hart, Shaffner & Marx, the well known Chicago clothing manufacturers, own a large building which is protected by an automatic sprinkling system of a modern and reliable type. The sprinkling system extends throughout the building. Pressure in the pipes is maintained by a 2000 gallon compression surge tank, which is normally half full of air at 150 lb. pressure and acts as a cushion for the system.



MOTOR-DRIVEN CENTRIFUGAL PUMP. HART SHAFFNER & MARX BUILDING

Water is kept in the surge tank under a pressure of not less than 140 lb. by a motor operated pump, shown in the accompanying illustration. The pump's capacity is 100 gallons a minute at 150 lb. per sq. in. pressure in excess of the supply pressure in the city main which is about 25 lb. The motor starts the pump automatically when the pressure drops to 140 lb. The air cushion tends to compensate for light leakage, so that practically constant pressure is maintained; frequent starting of the motor to replace small losses is therefore avoided. Under present conditions the outfit operates once in about every 10 days and runs but a few seconds until full pressure is restored in the tank.

The entire installation is provided with telegraphic indicators. One shows the exact height of the water level in the air cushion tank; another whether the pressure on any part of the system drops below the cut-in pressure of the pump; another tells whether the voltage is cut off from the control panel outside or at the switchboard. All main valves are provided with alarms which sound when the valves are closed.

The pump is of the horizontal three stage pattern, built by the Jeanesville Iron Works Company. Besides keeping up the pressure in the surge tank, the pump feeds a stand pipe service, so that hose connections may be made at several points on each floor in case of fire. A gravity roof tank of 40,000 gal. capacity is used as an auxiliary to the pump in feeding the sprinklers should anything happen to the motor, pump or control.

This roof tank, however, is not connected to the stand pipe system. The latter has to rely on regular steam fire engines in case of failure of the electric pump. The pump is so constructed that it is impossible to overload the motor in case of excessive water flow such as would be occasioned by the bursting of one or more hose lines.

The pump is of the horizontal 3 stage pattern, suction and discharge connections are both in the lower half; thus the upper half may be removed for inspection and repair without disturbing the main connections.

In addition to the 2 main bearings of the pump a marine type thrust bearing is provided at the end of the shaft for the purpose of taking up the end thrust. This bearing is supplied with forced lubrication by means of a scoop shaped oil thrower. The thrust bearing is also water jacketed, the water being taken from a connection made to the third stage of the pump, and its flow automatically regulated. The illustration also shows the hose connections provided on the discharge pipe for use in case of fire in the basement.

The motor is of Westinghouse make, direct current, 150 hp., 1400 r.p.m., 220 volt, and designed especially for service of this kind. The control which was furnished by the Cutler Hammer Company, is automatic although it is arranged for hand operation in case of emergency.

The installation described reduced the insurance premium on the building approximaately one-half.

THE FOLLOWING COLOR SCHEME for piping is from a German gas journal: Red means fire, whether it is a hydrant, bucket, axe or anything else. Green is for water pipes; blue, for air; white, steam; black, tar; rose, ammonia or alkalies; brown, oil; gray, vacuum; rose with red stripe, acids. Yellow is a general color for gases. If the yellow is alone, it means purified blast furnace gas, or if with a black ring, it is not purified; yellow with a blue ring means producer gas; with a rose-colored ring, illuminating or coke-oven gas; a green ring means water gas, and a brown ring oil gas.

FIRE PROTECTION

ALMOST important question which must be considered by the small town, the coast communities, and the large or isolated manufacturing plant, has reference to fire protection. The matter of expense enters in pretty much every such case. In addition, there is the problem of an adequate water supply under sufficiently high pressure. It is possible (and this has been proven in numerous instances) to solve the whole problem by means of a powerful pumping plant operated only when necessity arises. One of the most notable cases is that at Coney Island, the New York pleasure resort.

The buildings at this place have been and are very inflammable. In consequence of the conditions, fire policies were limited to 10 per cent of the value, and a 5 per cent rate charged. The location is distant from the general fire system of the Borough of Brooklyn. To maintain an adequate number of fire steamers to cope with the possibilities would have entailed a very heavy expense.

An abundance of water was, however, available. First, there was the city supply; and, second, the salt water of the immediate vicinity, if such water could be used. The question of power was, of course, important. What was needed was a solution of the power question which would enable a large total of power to become available quickly, and would entail little or no expense in the intervals when not required. This problem was successfully solved by using gas engines and supplying them with the ordinary illuminating gas. A large gas-holder was situated near by; with this suitable connections were made.

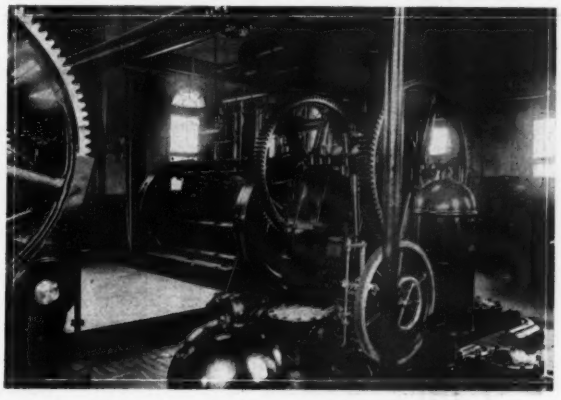
Three Nash gas engines of the vertical 3-cylinder, 4-cycle type were installed. The cylinders are 13¾ in. in diameter; and the stroke is 16 in. When these engines are run at 260 revolutions per minute, a horsepower of 175 is developed by each. This is accomplished with gas of but 590 B.t.u. per cubic foot by using only 17.4 cu. ft. per brake-horsepower per hour. The valves of one cylinder in each engine are arranged to permit the use of compressed air to start it off. There are 2 separate air compressors. One of these has its own small gas engine. There is in addition a series of storage tanks for compressed air, with capacity equal to starting all engines twice.

It will be seen from the foregoing that adequate provision has been made for starting up. In fact, the men in charge do not have to exert themselves at all. The compressed air starts the engine forward, operating through one of the 3 cylinders. The other 2 cylinders quickly develop power from the gas, in 1 or 2 revolutions, in fact. The engine is put into full operation by gas in 20 seconds. All 3 engines and the whole plant can be put into full operation in about 2½ min. It will thus be seen that they have a source of driving power which becomes available in a short space of time.

This power equipment drives an efficient pumping plant. This consists of 3 triplex double-acting piston-pumps built by the Goulds Manufacturing Co., Seneca Falls, N. Y. Each of these pumps is directly connected to one of the gas engines, and forms with it a water handling equipment independent of the other pumps. The pistons have a diameter of 12 in. and a stroke of 14 in. There is a capacity of 40.3 gal. at each revolution of the 3-arm crank-shaft. As the ordinary angular speed of the crank-shaft is 38.5 r.p.m. a pumping capacity of 1551 gal. per minute per pump is obtained. Each pump is driven by a pair of pinions which engage with spur gears arranged on the ends of the crank-shaft. The gear ratio is 1:5. The suction piping has a diameter of 12 in.; the discharge piping is 10 in.

Each of the pumps has a by-pass permitting the discharge to pass into the overflow pipe. While the engine is getting under way, the by-pass valve is open; but when the full speed is attained, this valve is gradually closed by an electric motor. The valve is opened or closed in 20 seconds; the electric motor automatically stops when its work of opening or closing the valve is completed.

The total capacity of the 3 pumps is 4650 gal. per minute. The pressure is 150 lb. per square inch at the pumps. For a hydrant ⅞ mile away the pressure falls only to 140 lb., when the full capacity of the plant is employed. The area protected totals about 65 acres. There are numerous hydrants so distributed that the whole energy of the pumping plant can be concentrated upon any one block of buildings. These hydrants have 2½-in. hose connections, and are joined to the service mains by 8-in. piping. The full capacity of 4650 gal. per minute can be developed with 15 to 20 streams.



GAS ENGINE DRIVEN PUMPING UNIT IN CONEY ISLAND PLANT

City water is brought into the plant. In addition there is suction connection with an adjacent body of water known as Coney Island Creek. This water is salt and the supply is inexhaustible. In case the city water should fail, the salt water supply could be utilized.

VENTILATED FURNACE ARCH

HEREWITH is illustrated a patented furnace arch that has given satisfaction in a number of plants where it is now being used; at this time 106 boilers, approximately 40,325 hp. many of the Stirling type, or others requiring wide span arches, have been equipped with it or are under contract. The cut shows the arch arranged for a vertical type boiler equipped with a traveling grate, but it can be designed to meet the requirements of all types of boilers or furnaces that call for an arch.

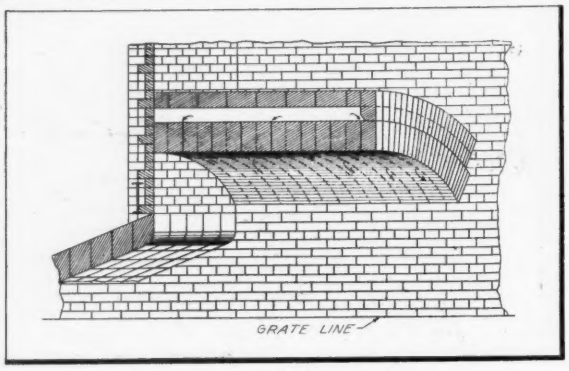
As the main or combustion arch is being laid up, a series of openings is formed in the joints between the brick, through which the draft draws a proper supply of air. These openings lead into an air chamber between the main arch and a single-ring arch thrown over it and which is sealed off at the rear. Into this chamber air is admitted at any convenient point from the outside, and in its travel over the combustion arch

it is distributed into the openings formed in the main arch, carrying the heat stored up into the furnace.

By proper arrangement of the openings, in addition to serving to cool the arch, they are serviceable as an expansion joint, preventing the arch from crushing and fracturing.

The question has been raised at times as to the loss in efficiency met with in introducing air over the fire. If efficiency was impaired to the extent of even ½ per cent, it would be better to stand the loss of a number of arches yearly, as the cost of the fuel wasted would more than counteract the saving made in arch maintenance. But out of hundreds of samples of gas analyzed, the efficiency has in no case been impaired; in fact, many samples taken when the air inlet was open to the atmosphere showed a higher per cent carbon dioxide than when the inlet was temporarily closed.

The practice so far has been to give personal supervision to the installing of the first arch in each plant, after which the mason contractor or local workmen



A VENTILATED FURNACE ARCH

laid up the remaining arches as required. A small charge was made per horsepower rating of the boiler to cover plans and supervision, which figure gave license to use the arch under each boiler for its remaining length of life, then a reduced figure was charged for each arch later put in.

As each boiler plant requires a special design to meet the requirements of boiler and furnace, an effort is made personally to inspect the conditions and design the arches accordingly, but it is possible from prints of the layout and detailed information, such as fuel used, draft available and service demanded, to prepare drawings and specifications which can be followed by furnace repairmen.

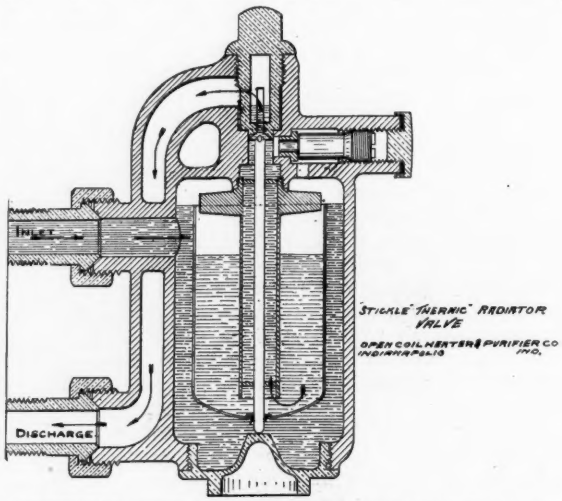
M. E. E. Carr, Monadnock Block, Chicago, Ill., the inventor, is prepared to refer to plants now equipped, giving data as to the improved service. As an illustration, the first arch put in October 31, 1909, stood up 23 months, while from an arch of the ordinary sprung type constructed of the best grades of fire brick obtainable and laid by skilled workmen, 4 to 5 months' service was all that the customer received or expected under the hard service demanded.

In another plant, where 48 arches have been installed, an average life of 20 months was met with, while previously a life of 6 months was all that could be expected. So far not a single failure has been encountered, nor has a single arch given less than double the service received from an ordinary arch, while many have given 300 to 400 per cent greater length of life, besides aiding in combustion and the prevention of smoke.

STICKLE THERMIC VALVE

ELIMINATION of many of the difficulties of steam heating systems is secured by the use of the Stickle open float valve. Steam cannot enter the radiator without first removing the air, therefore it is necessary to create and maintain a differential between the inlet and discharge of the radiator. This is expediently accomplished by the new thermic valve.

In use on the radiator, the bucket is down when the steam is admitted, leaving the valve open. The opening in the thermic plug permits the release of the



SECTIONAL VIEW STICKLE THERMIC RADIATOR VALVE

air and condensation. The steam then closes the thermic bypass, the bucket is floated and closes the valve, with the exception of a small discharge through a groove in the valve. This continuous discharge is less than the minimum condensation from the radiator. The accumulating condensation in the float overcomes the buoyancy, then it automatically opens and closes, maintaining a perfect water seal.

With the common closed float, the valve is closed when the steam is turned on and cannot open until the air is exhausted from the radiators. This is accomplished by means of a small opening through the float, thus prolonging the time necessary to bring the radiator into service. This action is reversed in the open float. When steam is admitted the valve is open and remains so until all of the air and condensation is removed. The thermostat bypass, at the top of the open float releases the air through the main valve, which provides a much larger air passage than the closed float valve.

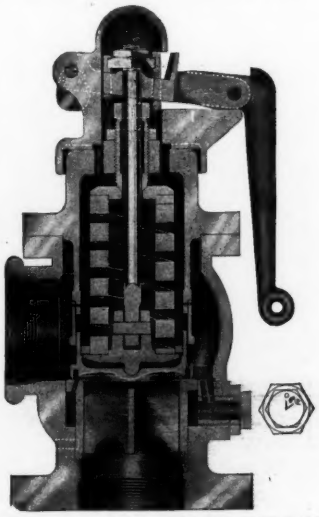
The Stickle Thermic Valve is the main feature of the Stickle system of vacuum and low-pressure heating, manufactured by the Open Coil Heater & Purifier Co. of Indianapolis, Ind.

AS AN EXAMPLE of reality that is more wonderful than any fiction is the account of boiler explosion at Orillia, Wash., in which a 100-hp. boiler exploded, wrecking everything in the vicinity, throwing fragments in every direction, sending a big piece of boiler plate up into the air to drop on a blacksmith shop at some distance away, and doing damage amounting to over $2500, and yet 6 men who stood about the boiler, one man being directly in front, escaped without serious injury. Two were slightly injured by flying debris, but not seriously.

IMPROVED POP SAFETY VALVE

Lock-Up Valve With Compound Lifting Attachment

THIS new design, made to comply with the latest revised laws of the State of Massachusetts, has the lifting attachment capable of raising the valve from the seat, ⅛ the diameter of the valve opening. The seat is beveled at an angle of 45 deg., the spring encased so that it is protected from the heat of the steam, and back pressure on the top of the valve is prevented. The pressure screw has a rounded bearing in the valve disk and a special bottom disk for taking the pressure of the spring which is separate



SECTION OF THE ASHTON IMPROVED POP SAFETY VALVE

from the valve disk. The spring is long, made of Jessop Sheffield steel, giving accuracy of adjustment and permanency.

Openings for both inlet and outlet are the full size of the valve opening. The pop lip is provided with a knife edge which wears evenly with the seat, thus giving unvarying amount of blow-down, even after long service, and the amount of the blow-down is regulated by an outside screw plug, which gives a quick, ready means of adjusting the amount of pop without taking the valve apart and while pressure is on the boiler. This valve is made in sizes from 2 to 6 in., by the Ashton Valve Co., Boston, Mass.

NEWS NOTES

THE SEATTLE ENGINEERING SCHOOL, of Seattle, Wash., has decided to install steam and gas engines, boilers, pumps, dynamos and other equipment in its new building now being constructed at 3rd Ave. and Pine Street. The school would like to receive, addressed to Wm. F. Baer, Manager, catalogs of such equipment so that he may make choice of designs and sizes.

ON JULY 20 a picnic will be held by the joint executive committee of the local engineering organizations of Cleveland at Luna Park. This joint committee consists of 3 delegates from each of the organizations and one day each year is set aside to be known as Engineer's Day. Last year the program consisted of races for men and women, for boys and girls, and general athletic sports which were purely for the love of the game. In the races prizes contributed by different firms interested in the organizations were given. The officers in charge of the outing are: President, Henry J. Baier, No. 5; vice-president, Thos. Murphy, No. 81; secretary-treasurer, Thos. W. Roberts, No. 47. Mr. Roberts' address is 603 American Trust Bldg., Cleveland, and further information or donations of prizes may be made to him.

AT A RECENT MEETING of the New York branch of the Institute of Operating Engineers, A. R. Maujer spoke on How to Make Boiler Testing Apparatus at Small Cost and How to Use It. He showed that expensive and complicated apparatus is not necessary to get data required for comparing results in the boiler room. A Bunsen burner costing $1 and a beam balance costing from $1 to $2, and a set of weights ranging from a milligram to 50 grams costing $1.80, and a few clay crucibles for a few cents each will enable one to make fuel tests of sufficient accuracy for comparison purposes. Mr. Maujer showed that many of the laboratory accessories can be duplicated in the workshop of an engine room at no expense other than a small amount of time and substitutes devised for others. An Orsat apparatus can be purchased complete for determination of flue gas analysis for from $2 to $20, depending on what determinations are to be made. The consensus of opinion is that the carbon dioxide determination is all that is necessary for comparison. Care and accuracy on the part of the operator are of more value than expensive apparatus.

H. G. Stott brought out in his lecture on April 2 some surprising facts and predicted that in 20 yr. we would be using simply the term "engineer" and getting away from the different subdivisions. He predicted that we would be using electricity 10 times more than now in ways not now thought of. He showed that in efficiency of utilizing power electricity can be rated at 70 per cent and steam at only 50 per cent, but, of course, the electricity is generated in the first place by steam. He showed also that experience in the plants of the Interborough Rapid Transit Co. have shown the cost for cooking by electricity to be about half that for gas. The figures were for gas 3½ per cent, for electricity 7 per cent, steam 8 per cent rated on efficiency of operation.

THE CHICAGO OFFICE of the Ashton Valve Co. has been removed to 174 North Market St., where its large line of steam specialties is now kept in stock and prompt and courteous service shown as always.

A FIRE DID ABOUT $10,000 damage to the plant of the Buffalo Foundry & Machine Co., Buffalo, N. Y., early in the morning of April 11th. Because of its steel and glass construction the building is practically fireproof excepting the roof, where the greatest damage was done. The building is 145 by 320 ft., and contains 175,000 sq. ft. of ribbed glass. The blaze started in the core-room and quickly spread to the roof which was in flames when the first firemen arrived. The job was extra hazardous because of the breaking glass, and it was a most stubborn fire to fight. No one was hurt. The plant was running as usual on Monday, April 15th.

ALUMNI OF STEVENS Institute of Technology recently paid a tribute to the mechanical genius and strong personality of Dr. James E. Denton, a noted engineer, who has long been associated with the faculty of Stevens Institute. Recently Dr. Denton was forced to retire from the more strenuous activities of his profession as engineer and teacher because of impaired health, and the alumni seized upon the occasion to present him a token of their love and esteem in the form of a watch and fob accompanied by a beautiful engraved testimonial, containing the signatures of a majority of the alumni and professors of Stevens Institute.

AT THE ANNUAL meeting of the stockholders of the Joseph Dixon Crucible Company, held at the Company's main office in Jersey City, N. J., Monday, April 15th, the retiring Board of Directors, consisting of Geo. T. Smith, William Murray, Edward L. Young, William H. Corbin, Geo. E. Long, William G. Bumsted and Harry Dailey, was unanimously reelected. Officers elected for the ensuing year are as follows: President, Geo. T. Smith; Vice-President, W. H. Corbin; Treasurer, Geo. E. Long; Secretary, Harry Dailey; Assistant Treasurer and Assistant Secretary, J. H. Schermerhorn. There were voted 9304 shares of a total of 10,000. A number of stockholders attended the meeting and expressed themselves as well pleased with the company's showing and with future prospects.

CATALOG NOTES

IN MANY PLANTS where hot water heating is used, it is desired to vary the temperature over considerable ranges according to the weather. For ordinary weather a low temperature is wished and for extreme cold a high temperature is desirable. To take care of such conditions the Klymax Heat Economizer, manufactured by the Kellogg-MacKay Co. of Chicago, has been especially designed and what it is and how it works are fully told in a pamphlet recently received.

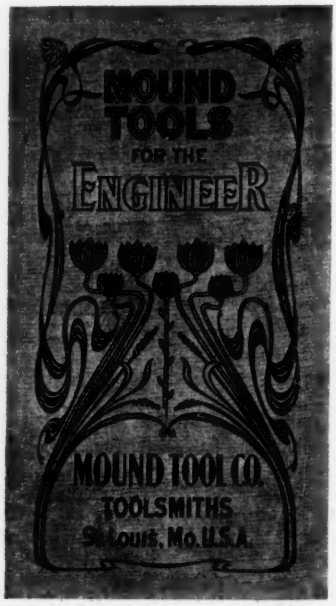
TESTS OF COLUMNS.—An investigation of the Value of Concrete for Structural Steel Columns, by Arthur N. Talbot and Arthur R. Lord, has just been issued as bulletin No. 56 of the Engineering Experiment Station of the University of Illinois. This bulletin gives an account of a series of tests to determine the strength of a structural steel column of considerable strength having a filling of concrete. The tests show that this type of column, if properly made, is a reliable and efficient structural member, and that nearly all the strength of both steel and concrete is developed. The tests also show that up to the point of failure of the column, the fireproofing shell of concrete adheres tightly to the remainder of the column. Copies of Bulletin No. 56 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

THE PEERLESS RUBBER MFG. CO., 16 Warren Street, New York City, has just issued an exceptionally attractive Catalog showing its Packings for all purposes; Belting; Steam, Air and Water Hose; Rubber Tiling and other Mechanical Rubber products. This book contains 200 pages, 5⅞ by 8¼ in. with limp cover. It is a model for convenient arrangement and an example of artistic printing correctly adapted to commercial purposes. There is hardly a page without its fine halftone engraving in colors, and there are many full-page colored plates showing the goods in use. The volume of information about the Company's products, together with a quantity of data compiled especially for engineers, makes this a book which every engineer will wish to have in his business library. This catalog is designated as No. 100, and can be had by writing to the Peerless Rubber Mfg. Co. and mentioning Practical Engineer.

THE MAGNOLIA METAL COMPANY has issued new booklets in English, Spanish and Portugese, containing testimonials and tests describing the value and uses of Magnolia Anti-Friction Metal and giving full directions for pouring the metal. These books are intended for general distribution and anyone can obtain a copy by addressing the company.

THOSE INTERESTED in easy cleaning of boilers will like to have the descriptions of the Vulcan soot cleaner for either return tube boilers or water-tube boilers sent out by G. L. Simonds & Co., Steinway Building, Chicago. These descriptions show the cleaners as installed ready for work and give in detail the specifications under which they are to be installed.

MOUND TOOLS FOR THE ENGINEER is the title of an attractive booklet issued by the Mound Tool & Scraper Co., of 7th and Hickory Sts., St. Louis. Inside, the booklet is as attractive as the cut of the cover shows it to be on the outside. It tells about a number of things which will help the engineer in his



work. These include tools for making keyways and oil ways, for taking out and putting in packing in difficult places, for cutting packing and gaskets, for scraping bearings and the like. Copy of this booklet can be had by addressing the Mound Co. as above and mentioning Practical Engineer.

BOGART GAS POWER ENGINEERING CO., Buffalo, N. Y., has just got out a new catalog describing its various types of engines. This is a neat publication giving halftone illustrations and line drawings, showing the points of interest about the Bogart engines. Particular emphasis is laid upon the enclosed bed Type ES single cylinder and the enclosed Type EST tandem engine. These catalogs are for distribution to those interested.

IN COMMEMORATION OF that great man and inventor, Richard Teller Crane, the Crane Co. has issued a booklet giving an account of his achievements, his beliefs on education and his relations to his employes and to society, which is an interesting and inspiring story of a life well and sincerely lived. It is a story well worth reading, a record worth emulating and a discussion worth thinking about. The book is called the Memorial Number of the Valve World, and we advise every man, engineer or otherwise, to send to the Crane Co., Chicago, Ill., for a copy, and then to read and digest it carefully.

Sparks From The Advertising Pages

50 Prizes For the 50 Best Letters

Just which advertisements appeal to you most? That is what we would like to find out and to do so we're offering 50 prizes for the 50 letters which seem to answer the question in the most comprehensive way.

Advertisers in Practical Engineer are anxious to know just where you think they have struck the right chord. They want to know your opinion of their advertisements and the reasons upon which you have based that opinion.

Now we don't expect any of you to write an exhaustive treatise on the advertising you see in Practical Engineer—in fact, we would rather that the letters be brief and to the point. What we want is simply your opinion—the way in which the various advertisements appeal to you and why.

We'd like to know the following four things about the advertisements in this (May 1st) number and the forthcoming issue of May 15th.

1st. Which advertisement has, in your opinion, the strongest attention value, and why? In other words, which advertisement attracts you most—makes you want to read it?

2nd. Which advertisement is the most interesting?

3rd. Which advertisement is the most convincing—which is the one that makes you feel that what it says is so?

4th. Which advertisements did you answer?

Just sit down with a copy of Practical Engineer and go through its advertising section, page by page. Pick out the advertisements that you consider best from each standpoint, and then in a few words tell us why you think so.

For example, here's just about what we want:

Practical Engineer, 537 S. Dearborn St.,
Chicago, Ill.
Gentlemen:—

(1) I consider the advertisement of the ——— ——— Co., to have the best attention value because the headline almost compels one to read what follows. The layout and general arrangement is also very attractive.

(2) The advertisement of the ——— Co., is the most interesting because it gave me several hints with regard to the reduction of power cost.

(3) The advertisement of the ——— Oil Filter Co., was the most convincing because it made me feel that everything it said was so and that I would be better off if I investigated it further.

(4) I answered the following advertisements:

Something like the above letter will do. We want your own opinion explained in your own way.

Fifty prizes will be awarded to the engineers who, in our judgment, answer the four questions in the clearest and most logical manner. These prizes are as follows:

(1) For the five best letters: A Richardson direct reading slide-rule for each of the five.

(2) For each of the ten second best: An improved finely tempered Scriber and Tram.

(3) For each of the ten third best: A convenient L. S. Starrett pocket level with strong, heavily nickel plated metal case.

(4) For each of the twenty-five fourth best: A copy of "Manual for Engineers," a leather bound pocket hand-book, full of useful information and data for the engineer.

This offer is open to everyone who reads Practical Engineer with the exception of advertising men, who are barred. We do this because we want the opinions of the men whom the advertisers are trying to reach.

All letters must be received by June 1st, in order to be considered in the awarding of the prizes, the winners of which will be announced in the June 15th issue of Practical Engineer.

Sit down *now* and study the advertising pages. Then write us your opinion. It will be time well spent.

TRADE NOTES

H. A. ROGERS CO., for 37 yr. in the railway, mill and mining supply business at 19 John Street, New York, have removed to 87 Walker Street, occupying the entire building, 6 floors, 90 ft. by 22 ft. The building has been entirely remodeled, not only to secure the maximum of space, but to afford every convenience for the storage, display, sale and delivery of the many and widely varying products handled. In the basement will be stored a large stock of gage glasses. The store floor will be a sample or show room for the display and sale of goods for which the company is agent, such as Morse Twist Drills, U. S. Gages, Arcade Files, Moncrieff Gage Glasses, etc. This floor is finished in oak and has superior facilities for receiving and dispatching goods.

The entire second floor is given to offices. At the front are private offices for Allen Merrill Rogers, chairman, and William A. Tucker, treasurer. Offices of the bookkeeping and buying departments are on one side, several desks for salesmen occupying the center, and on the opposite side is the library or archive department, perhaps the most complete possessed by any house in this line. The remaining floors afford much needed storage room, enabling the company to carry larger stocks than ever before.

EUREKA PACKING CO., of New York City, is sending out to its friends a unique Don't Worry Club Emblem, as shown by the cut herewith.

THE DELAWARE WATER CO., Delaware, Ohio, have purchased another set of MacDonald Shaking Grates from the Robb Engineering Co., Ltd., South Framingham, Mass.

DURABLA MFG. CO. after May 1 will occupy the entire 2nd story front of the building where it is now located, at 114 Liberty St., New York City. Its business is increasing rapidly because of the proved quality and reliability of the products, thus necessitating this increase in space occupied. Among these products are the Durabla high-pressure gage glass, a metallic glass of great strength and flexibility which remains clear under practically all circumstances and the sales of which have tripled within the last year. Another product, the Durabla high-pressure asbestos sheet packing, which has been on the market for 5 years, has proved equally efficient for low-pressure and water and for high pressure. A feature is that it can be rolled and unrolled without cracking, due, according to the company's statement, to the special bond which is used for holding the long fiber asbestos in sheet form.

A NEW MATERIAL for insulation against heat, cold and sound, composed of asbestos fiber and hair, made up in layers to give waterproof and fireproof protection, and called "Thermofelt," is described in a recent circular received from the Guyasuta Mfg. Co., Sharpsburg, Pa.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By engineer with second class Massachusetts license and 15 years' experience on compound and simple engines. Can do general repairs. First class references. Position preferred in Springfield, Mass., or Providence, R. I., but would accept in Conn. or New York State. Address Box 216, Practical Engineer, Chicago, Ill. 4-15-2

Help Wanted

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J.

ENGINEERS AND MECHANICS—To make big money selling incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and will not injure the most delicate skin. Small sample free. Byram Mfg. Co.. Box 3133, Boston, Mass. tf

Wanted

WANTED—EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one and two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

WANTED—An experienced salesman of steam specialties for Central West territory. State age, experience and where obtained and salary expectations. The Ohio Brass Co., Mansfield, Ohio. 5-1-1

For Sale

FOR SALE—INDICATOR, REDUCING WHEEL, planimeter. best make, in fine order. Examination allowed before payment. Price low—in fact, a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf

Patents and Patent Attorneys

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the local protection of the invention. Handbook for inventors sent upon request. 186 McGill building, Washington, D. C. tf

VALUABLE INVENTIONS WANTED—Mail description for free opinion of patentability immediately. Patents bought or sold for interested parties. A. P. Connor, E. E. Registered Patent Attorney, Washington, D. C. 5-1-2

Educational and Instruction

FREE TUITION BY MAIL—Civil service, drawing, engineering, electric wiring, agricultural, poultry, real estate, automobile, law, normal, academic, bookkeeping, shorthand courses. Matriculation, $5. Write for our free plan. Apply to CARNEGIE COLLEGE, Rogers, Ohio.

Miscellaneous

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write to-day. M. Y. C., 1413 W. Jackson Blvd., Chicago, Ill. tf